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The Dynamic Universe – space as a spherically closed energy system

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Abstract: The Dynamic Universe model comprises a holistic view and detailed study of space as a spherically closed 3-dimensional energy system in a 4-dimensional universe. It is based on zero-energy balance of motion and gravitation of space as a 3D surface of a 4-sphere – contracting and expanding in the direction of the 4-radius. Such a dynamic solution shows the rest energy of mass in space as the energy of motion mass possesses due to the expansion. DU shows relativity as a consequence of the conservation of total energy and the zero-energy balance in interactions in space, and allows the derivation of physical and cosmological predictions in relatively simple mathematics – with no need to rely on kinematically derived coordinate transformations. The postulates DU employs do not include the principle of relativity, the equivalence principle, or assumptions about the constancy of the velocity of light. Yet, for local phenomena, including near space, DU predictions are essentially the same as the corresponding predictions given by the special and general theories of relativity. Cosmology predictions in DU fit with observations without the need to free parameters like mass density and dark energy used in Friedman-Lemaître-Robertson-Walker (FLRW) cosmology. The Dynamic Universe model offers plausible basis for philosophical considerations and leads to an intelligible picture of physical reality from quantum phenomena to the cosmological structure and development of space. The universe in this model presents itself as an intricately ordered whole where local structures and expressions of energy and matter are inseparably connected to the rest of space.

Keywords: Unifying Theory, Relativity, Cosmology, Quantum Phenomena, Zero-Energy Principle

1. Introduction

1.1. Prologue, Early Findings

The total energy of mass object m in special relativity is expressed as $E = c\sqrt{(mc)^2 + p^2}$, the product of the velocity of light c and the absolute value of the orthogonal sum of the momentum p and the quantity mc. It is tempting to interpret mc as momentum mc_4 with c_4 as the velocity of space in a fourth metric dimension, perpendicular to space directions.

Search for the hidden velocity c_4 guided to the study of space as the 3-dimensional surface of a 4-sphere expanding with the energies of motion and gravitation in balance.

The study led to an avalanche: relativity appeared as a manifestation of the conservation of total energy in space – mass obtained an abstract but fundamental role as wavelike substance for the expression of energy, and cosmological predictions took on precise, simple mathematical forms.

1.2. Key Elements in the Dynamic Universe [1]

Primary philosophical choices:

1. Time and distance are coordinate quantities essential for human conception. Coordinate quantities are not used as variables to explain physical phenomena (e.g. like characteristic frequencies of atomic oscillators).
2. Energy is a postulated quantity and force is a derived quantity – the gradient of energy. The laws of motion are derived from the conservation of energy. Gravitational interaction is described as immediate sensing of the local gradient of gravitational potential.

Cosmological scale:

1. Space is studied as a closed energy system; 3-space is described as the 3-"surface" of a 4-sphere free to contract and expand with the energies of motion and gravitation in balance.

Consequences:

1. Motion of space in the fourth dimension creates the rest energy of mass against release of gravitational energy in the contraction phase of the 4-sphere; the velocity of light in space is determined by the velocity of space in the fourth dimension.
2. In the ongoing expansion phase the rest energy is paid back to gravitational energy.
3. The size of gravitationally bound systems like galaxies and planetary systems expands in direct proportion to the expansion of space along the 4-radius. A further consequence: galaxy space appears in Euclidean geometry (as observed).
4. Due to the precise geometry and dynamics of spherically closed space, predictions of central cosmological quantities get precise expressions.
5. Prediction for magnitude versus redshift of distant objects fits exactly with observations without dark energy or other experimental parameters.
6. Celestial mechanics derived from the energy balance establishes the stability of black holes.

Local phenomena:

1. The rest energy of a mass object is the local expression of the energy of the object. It is counterbalanced by the non-local gravitational energy due to all the other mass in space.
2. A state of rest is studied as an energy state rather than a location in space. A state of motion is characterized by the energy used in obtaining the motion.
3. Localized mass objects are described as mass wave resonators.

Consequences:

1. Relativity in the Dynamic Universe is relativity of the local to the whole rather than relativity between an observer and an object.
2. Mass obtains the meaning of wavelike substance for the expression of energy.
3. Motion is primarily related to the state from which it originates.
4. Motion in space reduces the rest energy of the moving object. As a consequence the characteristic frequencies of atomic oscillators are reduced.
5. Relative velocity between objects has kinematic meaning only.
6. Properties of mass waves are related to those of the wave function in quantum mechanics.
7. Quantum states appear as energy minima of resonant states rather than intrinsically discrete energy states.

1.3. General Appearance of Spherically Closed Space

Spherically closed space can be seen as a huge spherical pendulum. It gains motion from its own gravitation in a contraction phase and releases the motion back to gravitation in the expansion phase after passing a singularity.

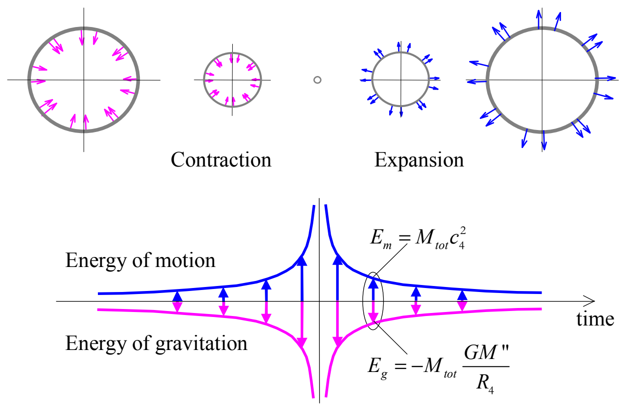


Figure 1. *The buildup and release of the rest energy of matter via contraction and expansion of spherically closed space.*

1.3.1. The Primary Energy Build-Up Process

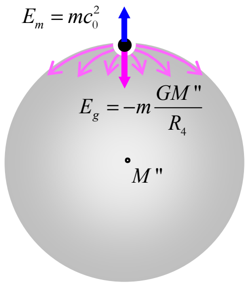
Einstein's original idea of the cosmological appearance of space according to general relativity in 1917 was the three dimensional surface of a 4-sphere [2]. Following the general conceptions at that time, Einstein was looking for a static solution which made him add the famous cosmological constant to the field equations of general relativity.

Gravitation in spherically closed space results in a shrinkage force that puts the structure into contraction. Mass in space gains motion against the release of the energy of gravitation. Like a spherical pendulum the energy of motion gained in the contraction is paid back to gravitation in an expansion phase after passing a singularity. The energy of motion gained from gravitation in the contraction is observed as the rest energy of mass, Fig. 1.

Mass exists as an abstract substance for expressing energy. Mass as such is not observable; locally, mass becomes observable when energized by motion. The development of zero-energy space starts from emptiness at infinity in the past and continues to emptiness at infinity in the future – or turns to a new cycle of existence.

Equating the energies of gravitation and motion, the current expansion velocity can be expressed in terms of the total mass in space, the gravitational constant and the current 4-radius, which can be obtained from the Hubble constant. Applying the current estimates of the Hubble constant and the average mass density in space, we obtain a prediction for the present expansion velocity $c \approx 300\,000$ km/s, which is the current velocity of light. A more elaborate calculation of the energy balance shows that the velocity of the expansion determines the velocity of light in space and sets the limit for the maximum velocity obtainable in space.

The linkage of velocities in space to the 4-velocity of space also means that the velocity of light decreases in the course of the expansion. The characteristic frequencies of atomic oscillators are directly proportional to the rest energy of the oscillating electrons, which means that the velocity of light is observed as being constant when measured with atomic clocks. The present relative decrease of the velocity of light is about $3.6 \cdot 10^{-11}$/year.



The balance of motion and gravitation

$$E_m + E_g = M_\Sigma c_0^2 - \frac{GM"M_\Sigma}{R_4} = 0$$

gives the expansion velocity of space as a function of the 4-radius R_4

$$c_0 = \pm\sqrt{GM"/R_4}$$

where G is the gravitational constant. In the 4-center of space, $M"$ is the mass equivalence of the total mass M_Σ.

Figure 2. *The dynamics of spherically closed space is determined by the balance between the energies of gravitation and motion. As an energy object, a local mass object has the rest of space as its antimatter – the rest energy of a local object is counterbalanced by the gravitational energy arising from the rest of space.*

The balance of the total rest energy and gravitational energy in space means that the rest energy of any mass object in space is balanced by the gravitational energy arising from all other mass in spherically closed space, Fig. 2. The rest energy of an object can be seen as the local expression, and the gravitational energy as the non-localized expression of that object's energy. A mass object has both local and non-local presence. The non-localized energy of the object is the negative counterpart of the local rest energy – which makes mass in the rest of space serve as complement to any localized mass object in space. All particles in space are linked to the rest of space, there is nothing intrinsically discrete in DU space.

1.3.2. Energy Balance in Space

It has been known for several decades that the rest energy of all matter in space is essentially equal to the total gravitational energy in space. In his lectures on gravitation in the early 1960s Richard Feynman stated [3]:

> *"...One intriguing suggestion is that the universe has a structure analogous to that of a spherical surface. If we move in any direction on such a surface, we never meet a boundary or end, yet the surface is bounded and finite. It might be that our three-dimensional space is such a thing, a tridimensional surface of a four sphere. The arrangement and distribution of galaxies in the world that we see would then be something analogous to a distribution of spots on a spherical ball".*

In the same lectures Feynman also pondered the equality of the rest energy and the gravitational energy in space [4]:

> *"If now we compare the total gravitational energy $E_g=GM_{tot}^2/R$ to the total rest energy of the universe, $E_{rest}=M_{tot}c^2$, lo and behold, we get the amazing result that $GM_{tot}^2/R = M_{tot}c^2$, so that the total energy of the universe is zero. — It is exciting to think that it costs nothing to create a new particle, since we can create it at the center of the universe where it will have a negative gravitational energy equal to $M_{tot}c^2$. — Why this should be so is one of the great mysteries — and therefore one of the important questions of physics. After all, what would be the use of studying physics if the mysteries were not the most important things to investigate".*

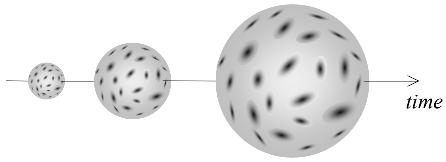


Figure 3*. Spherically closed space has its center in the center of the 4-sphere. Space is not Euclidean but it is observed as Euclidean because the velocity of light is linked to the velocity of the expansion velocity of space along the 4-radius, and gravitationally bound systems expand in direct proportion to the expansion of space.*

The Dynamic Universe approach means just combining Feynman's intriguing suggestion of spherically closed space to the great mystery of the equality of the total rest energy and gravitational energy. Obviously, Feynman did not take into consideration the possibility of a dynamic solution – in fact, such a solution does not work in the framework of the theory of relativity, which is based on time as the fourth dimension. In the DU approach the fourth dimension has metric nature and time is a universal scalar allowing the definition of velocity and momentum equally in space directions and in the fourth dimension. Momentum due to the motion of space in the fourth dimension and momentum within space combine to form a momentum four-vector and the related energy-momentum four-vector.

1.3.3. The Holistic Perspective

The primary energy buildup in space is described as interplay of gravitation and motion in the fourth dimension. The primary energy buildup process assumes homogeneous space with all mass uniformly distributed in the 3d volume. Buildup of mass centers in space requires motion in space directions. Conservation of energy in interactions in space requires that velocities in mass center buildup are acquired against release of gravitational energy by denting of local space. Accordingly, real space is not an ideal smooth 3-surface of a 4-sphere but it has certain topography in the fourth dimension; mass centers are surrounded by local dents in the direction of the fourth dimension.

As a major difference to the standard cosmology model, the dimensions of gravitationally bound local systems in space become related to the dimensions of whole space. In the ongoing expansion phase it means e.g. that sizes of galaxies and planetary systems expand in direct proportion to the expansion of whole space, Fig. 3. Likewise, all velocities in space are linked to the 4-velocity of space. The linkages, together with the spherical symmetry, explain why distant galaxy space is observed in Euclidean geometry.

In fact, the linkage of local gravitational systems to the expansion of space can also be seen in certain near space observations. In the Lunar Laser Ranging program [1,5] the distance to the Moon has been observed since the 1970s. The annual increase of the distance is 3.82 ± 0.007 cm/year. According to the DU analysis 2.8 cm of the increase comes from the expansion of space and only the remaining 1 cm results from tidal interactions which are used as the sole explanation in standard cosmology. DU predictions for the development of the length of a day and the number of days in a

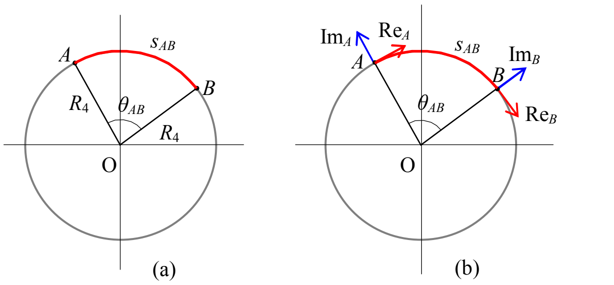


Figure 4. *(a) Universal coordinate plane crossing points A and B in space and the center of the 4-sphere space. Any point in space is at distance R_4 from the origin at point O. The shortest distance between points A and B in space is s_{AB} = arc{AB} along the circumference. (b) It is useful to apply complex coordinates in the study of local phenomena in space. In the local coordinates at points A and B the real axis has the direction of arc{AB} connecting points A and B in space. Due to the curvature of space in the fourth dimension, the local real and imaginary axes at A and B have different directions. The path of light from A to B follows the curvature of space in the fourth dimension; for an observer, it looks as if light is coming along a straight line as in Euclidean space.*

year are in good agreement with coral fossil data dating back 100–800 million years [1,6,7,8,9].

1.3.4. The Complex Coordinate System

Combining the effects of local motion in space and the motion of space it is useful to apply a complex coordinate system with the imaginary axis in the fourth dimension, and the real axis in the selected space direction studied, Fig 4. For local effects, the effect of the overall curvature of space can be neglected, which makes the local real axis linear in all three space directions.

2. Relativity in the Dynamic Universe

2.1. The Energy-Momentum Four-Vector

A state of rest in the DU is characterized as an energy state rather than a location in space. With reference to a state of rest, a state of motion is characterized by the energy required to obtain the state of motion.

The original trigger towards the Dynamic Universe model came from consideration of the physical meaning of the energy-momentum four-vector, illustrated by equation

$$E^2 = c^2\left[(mc)^2 + p^2\right] \tag{1}$$

Formally, the momentum four-vector can be seen as the vector sum of momentum *mc* in the fourth dimension orthogonal to the momentum *p* in any space direction. In the framework of special relativity, the fourth dimension is a time-like dimension which confuses the concept of a momentum in the fourth dimension. In the DU, the fourth dimension has metric nature and all mass in space is moving at velocity *c* in the fourth dimension. The rest energy appears as the energy of motion mass has due to the velocity *c* in the fourth dimension

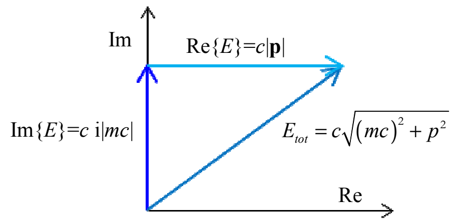


Figure 5. *Complex function presentation of momentum and the energy of motion.*

$$E = c\left|\mathbf{p}\right| = c \cdot mc \tag{2}$$

Formally, the rest energy, the energy of motion in the fourth dimension, is the product of velocity *c* and the momentum *p* just like the energy of electromagnetic radiation propagating at velocity *c* in space.

It is useful and illustrative to apply complex function presentations to the momentum and the energy of motion, Fig. 5. The absolute value of the complex energy of motion is equal to the total energy of special relativity. The complex function presentation discloses the linear relation of the energy of motion and the momentum as

$$E_m^{¤} = c\left(\mathbf{p}^{¤}\right) = c\left(\mathbf{p} + \mathbf{i}\,mc\right) \tag{3}$$

with the absolute value

$$\left|E_m^{¤}\right| = c\sqrt{(mc)^2 + p^2} \tag{4}$$

Superscript "¤" has been used as the notation of a complex function. The imaginary component of the momentum describes the momentum in the fourth dimension; a mass object at rest in a local energy frame has the imaginary component of the energy of motion only, electromagnetic radiation has finite real component and zero imaginary component. The complex form (3) applies both to mass objects and to electromagnetic radiation.

2.2. Unified Expression of Energy

For energy bookkeeping, it is useful to formulate the different expressions of energy in a unified form. A key element is the removal of the velocity of light from the Planck constant.

2.2.1. Coulomb Energy

In the DU framework, the velocity of light is not constant. It is therefore important to analyze the possible linkage of different physical constants to the velocity of light. Such an analysis suggests, e.g., that the unit charge *e*, the magnetic constant (vacuum permeability) μ_0, and the fine structure constant α are independent of the velocity of light. When expressed in terms of these three constants, the Planck constant *h* appears as being directly proportional to the velocity of light,

$$h = \frac{e^2 \mu_0}{2\alpha} c \tag{5}$$

It is useful to define the *intrinsic Planck constant*, $h_0 = e^2\mu_0/2\alpha = h/c$, which is independent of the velocity of light. The intrinsic Planck constant, h_0 has the dimensions of mass·distance [kg·m], which converts the Planck equation into form

$$E_\lambda = h \cdot f = h_0 c \cdot f = \frac{h_0}{\lambda} c^2 \tag{6}$$

or more generally as

$$E_\lambda = c\left|\frac{h_0}{\lambda}\mathbf{c}\right| = c \cdot |\mathbf{p}| = c\left|m_\lambda \mathbf{c}\right| = m_\lambda c^2 \tag{7}$$

where $\lambda = c/f$ is the wavelength of the radiation quantum. The quantity h_0/λ has the dimension of mass [kg]. In the last form of (7) the quantity h_0/λ is denoted as m_λ, the *mass equivalence of a quantum of radiation*. The energy of a quantum of radiation has the same form as the rest energy of mass; a mass object has its rest momentum in the imaginary direction only, radiation has its momentum in a space direction, in the direction of the real axis only.

By applying the intrinsic Planck constant h_0, the magnetic constant μ_0, and the fine structure constant α, the unified expression of energies can be extended to Coulomb energy related to point-like charges q_1 and q_2 at distance r from each other as

$$E_{EM} = \frac{q_1 q_2}{4\pi\varepsilon_0 r} = N_1 N_2 \frac{e^2\mu_0}{4\pi r} c^2 = N_1 N_2 \alpha \frac{h_0}{2\pi r} c^2 = m_{EM} c^2 \tag{8}$$

where the quantity

$$m_{EM} = N_1 N_2 \alpha \frac{h_0}{2\pi r} \tag{9}$$

is referred to as the mass equivalence of the Coulomb energy.

2.2.2. Wavelength Expression of Mass

Equations (8) and (9) illustrate the presence of mass in the expressions of the energy of radiation and Coulomb energy. By applying the intrinsic Planck constant and Compton wavelength λ_m, the rest energy of a mass object can be expressed as

$$E_m = c \cdot mc = mc^2 = \frac{h_0}{\lambda_m} c^2 \tag{10}$$

where the Compton wavelength λ_m appears as the wavelength equivalence of mass m, reciprocally to the mass equivalence of radiation.

In the DU framework, mass can be seen as wavelike substance for the expression of energy – not only via motion and gravitation of mass objects but also via electromagnetic expressions of energy.

2.2.2. Gravitational Energy

Mass appears as a first order factor in all expressions of energy, which illustrate the character of mass as the "substance for the expression of energy". In the case of gravitational energy, local mass m "senses" the gravitational potential built up by all other mass in space

$$E_g = -\int_V \frac{G\rho}{r} dV \cdot m = -\mathrm{i}\frac{GM''}{R_4} m \tag{11}$$

Due to the spherical symmetry of DU space, the global gravitational potential due to mass in whole space appears as the imaginary component of gravitation – like gravitational potential due to hypothetical point mass *M"* at the 4-center of spherically closed space. The negative imaginary gravitational energy in (11) balances the rest energy of the local mass *m*.

Gravitational force can be seen as a manifestation of Aristotle's *entelecheia*, the natural trend for the actualization of potentiality. Such an approach to gravitational force means immediate gravitation by sensing the local gradient of the local gravitational potential. There is no need for gravitons of other gauge bosons for mediating the gravitational force. As already shown by Pierre-Simon Laplace the stability of the planetary system requires immediate gravitational interaction. Henri Poincaré pointed out these contradictory results out when considerations of the relativity theory in the early 1900s suggested gravitational interaction at the speed of light.

Mass is considered as the primary conservable in space. Mass manifests energy via motion and gravitation as energized matter as well as via electromagnetism.

2.3. Buildup of Motion at Constant Gravitational Potential

Let's now apply the complex function (denoted by superscript ¤) presentation of the energy of motion (3) and the unified expression of the Coulomb energy (8) to the buildup of momentum and kinetic energy of a charged particle with mass *m* in an accelerator.

At the state of rest in the accelerator's energy frame the particle has only the rest energy,

$$E_{rest} = \left|E^{¤}_{m(0)}\right| = c\left|\mathbf{p}^{¤}\right| = c \cdot \left|\mathbf{i}mc\right| \tag{12}$$

The Coulomb energy released in the accelerator results in momentum p in space (the real axis) and increases the energy of motion by the Coulomb energy released as

$$\Delta E = E_{EM} = \frac{q_1 q_2 \mu_0}{4\pi r} c^2 = m_{EM} c^2 = \Delta m \cdot c^2 \tag{13}$$

The complex energy of motion of the accelerated particle thus becomes

$$E_m = c \cdot mc + c\Delta mc = c \cdot (m + \Delta m) c \tag{14}$$

which illustrates the mass contribution Δm by the Coulomb energy. In complex form (14) can be expressed as

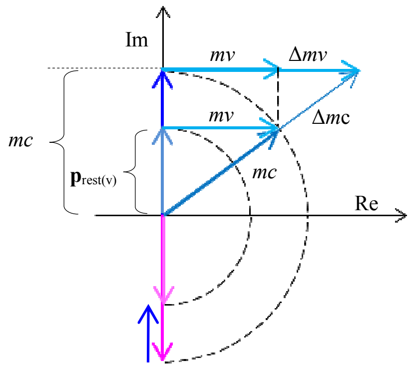


Figure 6. *(a) Buildup of momentum of mass object m by insert of energy ΔE = c·Δmc and the resulting momentum* ***p*** *= (m+Δm)****v*** *in space, in the direction of the real axis. (b) Share mv of the momentum in space originates from the real component of the "turned" rest momentum and the share Δmv from the mass contribution from Coulomb energy. The imaginary part of the turned rest momentum appears as the rest momentum of the moving object,* $\mathbf{p}_{rest(v)}$.

$$E_m^{\square} = c\left|\mathbf{p}^{\square}\right| = c\cdot\left|\mathbf{i}\,mc+\mathbf{p}\right| = c\cdot\left|\mathbf{i}\,mc+\left(m+\Delta m\right)\mathbf{v}\right| \qquad (15)$$

where **v** is the velocity resulting in momentum **p** in space (real axis), Fig.6.

Mass $m+\Delta m$ in (14) and (15) corresponds to the *relativistic mass* in special relativity. An essential difference with special relativity, however, is that the increased mass of an object in motion *is not a consequence of the velocity* as explained by special relativity, but the mass provided by the potential energy, corresponding to the amount of the *substance needed to obtain the velocity*.

As illustrated in Fig.6, the share *mv* of the momentum in space originates from the real component of the rest momentum turned in the direction of the total momentum, and only the share Δ*mv* comes from the acceleration energy. The imaginary component of the turned rest momentum appears as the rest momentum $\mathbf{p}_{rest(v)}$ and the corresponding rest energy of the object moving at velocity *v,*

$$E_{rest(\mathrm{v})} = c\cdot mc\sqrt{1-\left(v/c\right)^2} \qquad (16)$$

As discussed later in this paper, the characteristic frequencies of atomic oscillators are directly proportional to the rest momentum of the oscillating electrons. *The reduction of the ticking frequency of an atomic clock in motion is due to the reduced rest momentum of the oscillating electrons*.

The state of motion is measured in terms of the energy input used to achieve the motion – the state of motion should not be defined as relative velocity to an arbitrary observer.

The reduced rest momentum (mass) of an object moving in space is the counterpart of the "relativistic momentum" (or mass) in space.

In an analysis based on the zero-energy balance in space, we can find that the reduction of the rest energy related to buildup of motion in space is exactly the work done against the imaginary gravitational energy arising from all mass in the rest of space. The same can be concluded from the force balance: Motion as central motion in spherically closed space reduces the effective imaginary gravitational force via the central force created by the motion. *This is an exact quantitative explanation of Mach's principle*.

2.4. Buildup of a Mass Center in Space, the Velocity of Free Fall and Escape

There is no mass contribution available in the buildup of motion in free fall in space. In free fall the velocity is obtained against the reduction of the 4-velocity of space via tilting of space.

In hypothetical homogeneous space mass is uniformly distributed in space. Accordingly, there are no gradients of gravitational potential in space. Buildup of a mass center by conserving the total energy requires denting of local space around the developing mass center; the rest energy $E_{rest(0)}$ in homogeneous space becomes divided into orthogonal components: $\mathrm{Im}\{E_{(\varphi)}\}=E_{rest(\varphi)}$ as the rest energy in the local tilted space and $\mathrm{Re}\{E_{(\varphi)}\}= c\cdot|\mathbf{p}_{ff}|$, as the real component of the energy of motion of free fall in local space dented by angle φ,

$$\mathrm{Im}\left\{E_{(\varphi)}\right\} = E_{rest(\varphi)} = E_{rest(0)}\cos\varphi = c_0\cdot mc \qquad (17)$$

The real component of the energy of motion in free fall is

$$\mathrm{Re}\left\{E_{(\varphi)}\right\} = c_0\left|\mathbf{p}_{ff}\right| = E_{rest(0)}\sin\varphi = c_0\cdot mv_{ff} \qquad (18)$$

where c_0 is the velocity of light (the 4-velocity) in non-tilted space and *c* the velocity of light (the 4-velocity) in tilted space. In free fall, there is no source for mass input for the buildup of momentum and kinetic energy. The momentum of kinetic energy is built up against reduction of the rest momentum and the velocity of free fall is obtained against reduction of the imaginary velocity of space via tilting of space as

$$v_{ff(\varphi)} = c_0\sin\varphi = c_\varphi\tan\varphi \qquad (19)$$

In full symmetry with the complex energy of motion, tilting of space around the local mass center creates a real component to the gravitational energy in the tilted space complex plane. The gravitational energy released to the kinetic energy of free fall is equal to the reduction of the imaginary gravitational energy due to tilting.

The tilt angle can be expressed in terms of the local gravitational energy released as

$$\Delta E_g = E''_{g(0)} - E''_{g(0)}\cos\varphi = E''_{g(0)}\left(1-\cos\varphi\right) \qquad (20)$$

where $E''_{g(\varphi)} = E''_{g(0)}\cos\varphi$ is the local imaginary gravitational energy counterbalancing the local rest energy $E_{rest(\varphi)}$ at the local gravitational state characterized by tilt angle φ.

The cosine of the tilt angle can be expressed in terms of the gravitational factor δ, defined by equation

$$\cos\varphi = 1 - GM/r_0c^2 = 1-\delta \qquad (21)$$

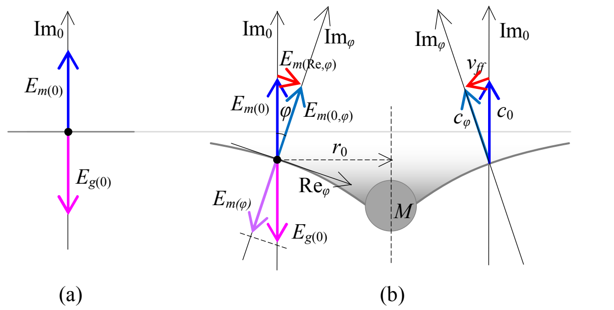


Figure 7. *(a) In homogeneous space mass has rest energy in the imaginary direction only. The rest energy is balanced by equal and opposite gravitational energy arising from the rest of space. (b) Buildup of a mass center in space results in a local dent in the fourth dimension. In tilted space the local rest energy and the corresponding imaginary component of gravitational energy are reduced. The local velocity of light, which is determined by the velocity of space in the local fourth dimension, is reduced. The velocity of free fall is the vector difference of the imaginary velocities in homogeneous and tilted space.*

where G is the gravitational constant, M is the mass of the local center, and r_0 the distance of mass m from the local center M in the direction of non-tilted space, Fig. 7.

The imaginary velocity of space is reduced by factor cos φ in tilted space, which means that also the velocity of light in tilted space is reduced

$$c_\delta = c_0 \cos\varphi = c_0 (1-\delta) \quad (22)$$

The reduced velocity of light in tilted space reduces the rest momentum and rest energy of a mass object in the vicinity of a mass center in space. As a consequence, the ticking frequency of atomic oscillators is reduced. Together with the increased distances in tilted space the reduced velocity of light results in bending of light paths near the center, as well as the Shapiro effect, observed as delayed signal transmission.

Combining the effects of motion and gravitation on the rest energy of mass gives

$$E_{rest(\delta,\beta)} = E_{rest(0,0)} (1-\delta)\sqrt{1-\beta^2} = m_0 c_0^2 (1-\delta)\sqrt{1-\beta^2} \quad (23)$$

The locally available rest energy is affected by local gravitational state by the factor (1–δ) and by local motion by factor $\sqrt{1-\beta^2}$, where $\beta=v/c$, and v is the velocity of the mass object in the local energy frame sustaining the velocity.

2.5. From Local to Global Relativity

The special theory of relativity relies on the relativity principle and introduces relativity as relativity between an observer and an object. Relativity concerns rectilinear motion and is expressed in terms of coordinate transformations by dilating time and contracting length. The general theory of relativity extends special relativity to accelerating motion relying on the equivalence principle.

The Dynamic Universe relies on the conservation of total energy which eliminates the need for both the relativity principle and the equivalence principle. Relativity in the DU is expressed in terms of locally available rest energy balanced by local imaginary gravitational energy from all mass in the rest of spherically closed space.

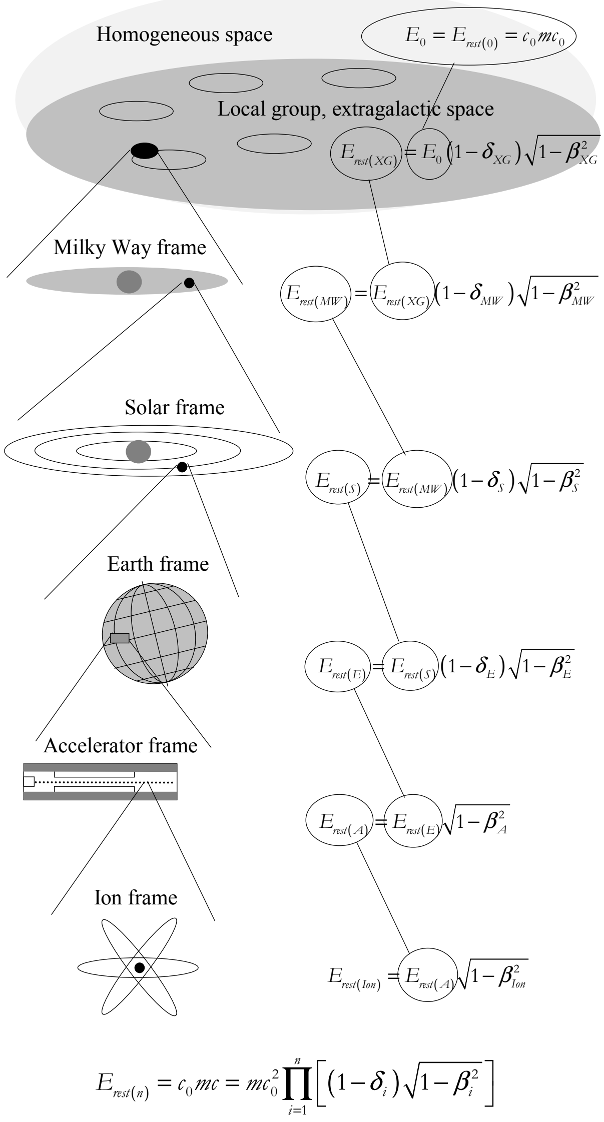


Figure 8. *The rest energy of an object in a local frame is linked to the rest energy of the local frame in its parent frame. The system of nested energy frames relates the rest energy of an object in a local frame to the rest energy of the object in homogeneous space.*

In short, combining the motion and gravitation of whole space to the local motion and gravitation by conserving the total energy, shows relativity as relativity of local to the whole rather than relativity of an observer and an object.

Instead of expressing relativity in terms of proper time and proper distance, relativity in the DU is expressed in terms of locally available energy. In this connection, *local* shall be understood as the reference to a local energy state rather than to a specific location in space. Objects on the Earth are subject to motion and gravitation in the Earth's gravitational frame and in all the parent frames, the Solar frame, the Milky Way frame, the Local Group frame and finally the hypothetical homogeneous space as illustrated in Fig. 8. Motion and local gravitation in each frame reduce the rest energy and the corresponding global gravitational energy of objects on the Earth. Combining the effects of motion and gravitation in the multilevel energy structures in space, the rest energy and the global gravitational energy can be expressed in forms

$$E_{rest(n)} = c_0 m_{rest(n)} c = m_0 c_0^2 \prod_{i=0}^{n} \left[(1-\delta_i) \sqrt{1-\beta_i^2} \right] \quad (24)$$

and

$$E_{g(global)} = -\frac{GM"m}{R"} = -\frac{GM"m_0}{R"_0} \prod_{i=1}^{n} \left[(1-\delta_i) \sqrt{1-\beta_i^2} \right] \quad (25)$$

respectively.

It is illustrative to divide the effects of gravitation and motion on the rest energy to the local velocity of light and the local rest mass, respectively, as

$$c = c_0 \prod_{i=0}^{n} (1-\delta_i) \quad (26)$$

and

$$m = m_0 \prod_{i=0}^{n} \sqrt{i-\beta_i^2} \quad (27)$$

where c_0 and m_0 are the velocity of light (the imaginary velocity of space) and mass in hypothetical homogeneous space. Applying the local velocity of light c and the local mass m, the rest energy can be expressed as

$$E_{rest} = c_0 \cdot mc \quad (28)$$

Based on the orbital velocities recognized in the Earth's parent frames, the local mass m and velocity of light in the Earth's gravitational frame are of the order of ppm smaller than m_0 and c_0, respectively.

In the Earth's gravitational frame, equation (24) can be expressed in form

$$E_{rest} = c_0 mc = c_0 m_{0\delta} c_{0\delta} (1-\delta) \sqrt{1-\beta^2} \quad (29)$$

where $m_{0\delta}$ and $c_{0\delta}$ are the mass and velocity of light at the Earth's orbit in the Solar frame, without the presence of the Earth. The gravitational factor δ and the velocity ratio β are defined by the gravitational state and velocity of mass object m, respectively, in the Earth's gravitational frame. The frequency of atomic clocks in Earth's gravitational frame can be expressed as

$$f_{\delta,\beta} = f_{0,0} (1-\delta) \sqrt{1-\beta^2} \quad (30)$$

where $f_{0\delta}$ is the frequency of a hypothetical clock at the Earth's orbit in the Solar frame, without the presence of the Earth. Equation (30) corresponds to equation

$$f_{\delta,\beta} = f_{0,0} \sqrt{1-2\delta-\beta^2} \quad (31)$$

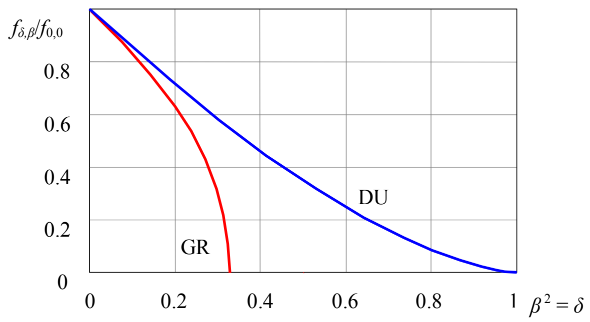


Figure 9*. The difference in the DU and GR predictions of the frequency of atomic oscillators at extreme conditions when $\delta = \beta^2 \rightarrow 1$. Such condition may appear close to a black hole in space. The GR and DU predictions in the figure are based on equations (31) and (30), respectively.*

derived from the general theory of relativity. At satellite distances from the Earth the difference between the frequencies given by the two formulas is of the order of 10^{-18}, which is too small to be detected. In extreme conditions the difference, however, is meaningful. At a circular orbit ($\delta=\beta^2$) around a black hole the GR clock stops when the gravitational factor and velocity squared exceed 0.33. The frequency of the DU clock goes smoothly to zero at $\delta=\beta^2=1$, Fig. 9.

2.6. Comparison of Celestial Mechanics in DU Space and GR Space-Time

The replacement of the equivalence principle with the conservation of total energy in gravitational interactions removes the instability of orbits and the unexpected clock behavior predicted by general relativity in the vicinity of black holes.

Bending of DU space is based on the conservation of energy, bending of space-time in general relativity is based on the equivalence principle. Predictions to near space phenomena like the GPS clocks are the same up to the 18th decimal. In high gravitational fields like in the vicinity of black holes the difference is remarkable: Orbits around GR based Schwarzschild black holes become unstable when the orbital radius is smaller than three times the Schwarzschild critical radius. In the DU framework the critical radius is half of the Schwarzschild critical radius and orbits around the black hole are stable down to the critical radius.

The basis of instability in the GR prediction can be seen in the predicted orbital velocity of an object in a circular orbit: The orbital velocity exceeds the escape velocity when the radius of the orbit is less than 3 times the Schwarzschild critical radius, Fig. 10. The reason for the predicted orbital velocity in Schwarzschildian orbits can be traced back to the relativistic mass in Schwarzschild space − which is a consequence of the kinematic origin of the relativistic mass in special relativity and the equivalence principle applied in general relativity. In Schwarzschild space, the critical radius is $r_{c(Schwarzschild)} = 2GM/c^2$, which is twice the critical radius $r_{c(DU)} = GM/c^2$ in the DU. In Schwarzschild space, the critical radius originates from the boundary condition equating Newtonian

Table 1. *Predictions related to celestial mechanics in Schwarzschild space [15] and in DU space. In DU space velocity ratio β is the velocity relative to the velocity of light in the apparent homogeneous space of the local singularity, which corresponds to the coordinate velocity in Schwarzschild space.*

	Schwarzschild space	**DU space**
Velocity of free fall and escape ($\delta = GM/rc^2$, $\beta = v/c$)	$\beta_{ff} = \sqrt{2\delta}\,(1-2\delta)$ (coordinate velocity)	$\beta_{ff} = \sqrt{1/(1-\delta)^2 - 1}$
Orbital velocity at circular orbits	$\beta_{orb} = \frac{1-2\delta}{\sqrt{1/\delta - 3}}$ (coordinate velocity)	$\beta_{orb} = \sqrt{\delta(1-\delta)^3}$
Orbital period in Schwarzschild space and in DU space	$P = \frac{2\pi r}{c}\sqrt{\frac{2}{\delta}}$, $r > 3 \cdot r_{c(Schwd)}$	$P = \frac{2\pi r_c}{c_{0\delta}}\left[\delta(1-\delta)\right]^{-3/2}$
Perihelion advance for a full revolution	$\Delta\psi(2\pi) = \frac{6\pi G(M+m)}{c^2 a(1-e^2)}$	$\Delta\psi(2\pi) = \frac{6\pi G(M+m)}{c^2 a(1-e^2)}$

gravitational energy $E_g = GMm/r$ with Newtonian kinetic energy $½mv^2$. In the DU, Newtonian gravitational energy applies in homogeneous space only, and becomes equated, as the imaginary gravitational energy, with the imaginary energy of motion, the rest energy $E_{rest}=mc^2$, thus resulting in critical radius $r_{c(DU)}=GM/c^2$. Table 1 compares the predictions for free fall and orbital velocities in Schwarzschild space and in the DU.

Experimental evidence supporting the DU predictions comes from fast periods observed at the black hole at the center of the Milky Way, the compact radio source Sgr A*. The estimated mass of Sgr A* is about 3.6 times the solar mass which means

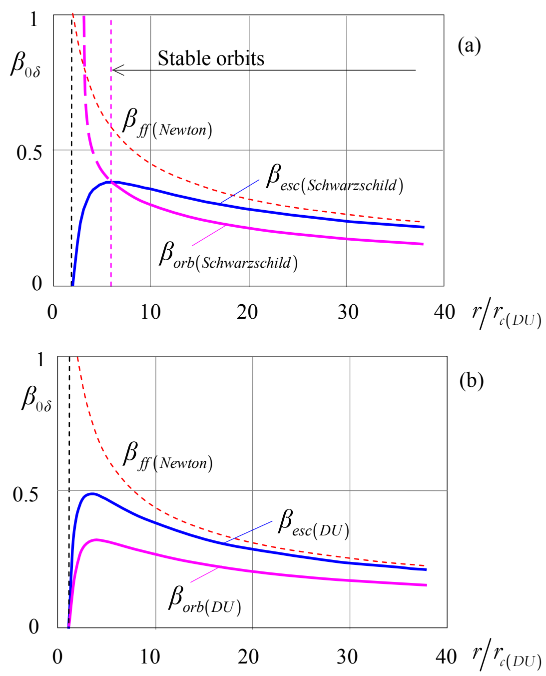


Figure 10. *a) The escape velocity and the orbital velocity at circular orbits in Schwarzschild space. The curves are based on the equations in Table1, given in the text book by J. Foster and J. D. Nightingale [14]. b) The escape velocity and the orbital velocity at circular orbits in DU space. The velocity of free fall in Newtonian space is given as a reference. Slow orbits between* $0 < r < 2 \cdot r_{c(DU)}$ *in DU space maintain the mass of the black hole.*

$M_{black\ hole} \approx 7.2 \cdot 10^{36}$ kg, which in turn means a period of 28 minutes as the minimum for stable orbits in Schwarzschild space. The shortest observed period at Sgr A* is 16.8 ± 2 min [12] which is very close to the prediction for the minimum period 14.8 min in DU space at $r = 2 \cdot r_{c(DU)}$, Fig. 11.

In fact, the problem arising from the equivalence principle is seen also in the GR prediction for the perihelion shift of Mercury: the prediction gives the missing shift observed, but the expression includes a cumulative term which increases the orbital radius. When calculated for a single rotation the increase of radius can be neglected, but if calculated for multiple rotations, Mercury should have been cast out of the solar system in less than half a million years [1], Fig.12.

2.7. Re-Evaluation of the Theory Structures

2.7.1. Cancellation of the Equivalence Principle

The analysis of motion in DU shows that kinetic energy built up in free fall from gravitational energy is obtained against reduction of the locally available rest energy, whereas kinetic energy built up at constant gravitational potential requires mass insertion like release of Coulomb energy.

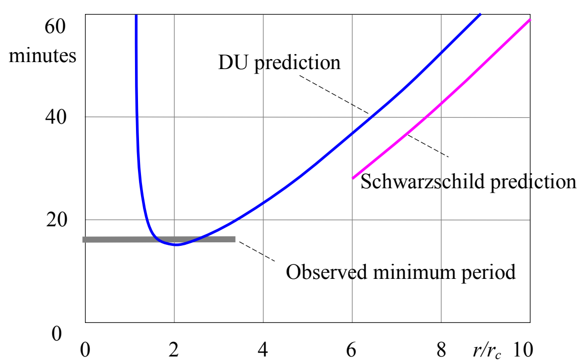


Figure 11. *The predictions in Schwarzschild space and in DU space for the period (in minutes) of circular orbits around Sgr A* in the center of Milky Way. The shortest observed period is 16.8 ± 2 min [12] which is very close to the minimum period of 14.8 minutes predicted by the DU. The minimum period predicted for orbits for a Schwarzschild black hole is about 28 minutes, which occurs at* $r = 3 \cdot r_{c(Schwd)} = 6 \cdot r_{c(DU)}$. *A suggested explanation for the "too fast" period is a rotating black hole (Kerr black hole) in Schwarzschild space.*

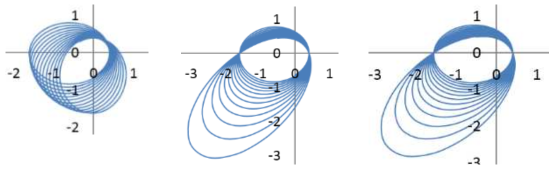


Figure 12. *Development of perihelion advance according predictions in (a) DU [1] 0-90°, (b) Berry 0-45°[13], (c) GR, Weber 0-45° [14]. In (b) and (c) the orbiting object is cast out of the orbit when the cumulated advance exceeds 45°.*

Generally, kinetic energy can be expressed as the increase of the total (complex) energy of motion as

$$E_{kin} = c_0\left(\Delta \mathbf{p}\right) = c_0\left(c\Delta m + m\Delta c\right) \tag{32}$$

where c_0 is the imaginary velocity of hypothetical homogeneous (non-tilted) space and c the imaginary velocity of space in local (tilted) space. The first term in parenthesis in (32) describes the buildup of kinetic energy by mass insertion at constant gravitational potential, the second term describes the buildup of kinetic energy against release of gravitational energy and the associated reduction of the local velocity of light.

The two different mechanisms of the buildup of kinetic energy cancels the equivalence principle postulated in Newton's celestial mechanics and in general relativity.

2.7.2. The Concepts of Velocity, Momentum, Force and Energy

Historically, the most obvious quantities observed were matter and motion. Motion was first related to the concept of force to actuate motion, then to momentum maintaining motion. The state of motion was primarily expressed in terms of velocity, which led to a kinematic approach to the reference at rest and the adoption of the relativity principle. In the Dynamic Universe, the state of motion is primarily expressed in terms of the energy needed in obtaining the motion.

The principle of relativity was first explicitly stated by Galileo Galilei, who was also celebrated for invalidating Aristotle's laws of motion by showing that the velocity in free fall is independent of the mass of the falling object, and that uniform motion continues without a force acting on the moving object.

In fact, the Alexandrian polymath scientist John Philoponus, about 1000 years before Galilei had criticized Aristotle's *movent* by introducing *impetus*, as a property of the moving object obtained when the object was put into motion. Motion continued until impetus was removed. Planets conserved their impetus while moving in vacuum without air resisting the motion. Impetus was identified as the momentum, the product of mass and velocity, by the French priest and philosopher Jean Buridan in the 1300s. The conservation of momentum was first proposed René Descartes as God's way of operating. Mathematically, the conservation of momentum, as well as the force needed to change the momentum (or velocity) was established by Newton's laws of motion.

Unlike Newton, Gottfried Leibniz linked the "living force" *vis viva, mv^2*, needed to obtain a velocity, to the "dead force" *vis mortua* so released. With modern concepts, Leibniz's *vis viva* meant kinetic energy and his *vis mortua*, potential energy related to gravitation or e.g. tension in an elastic material. Leibniz recognized the conservation of energy, but was not able to formulate the laws of motion using the concepts of *vis viva* and *vis mortua*. In fact, the concept of energy as work and integrated force was understood only as recently as the 1800s, finally as a part of thermodynamics.

Aristotle made a difference between natural motion due to gravitation, and forced, horizontal motion sustained by Aristotle's movent. Interestingly, in the DU framework, there is a difference in the buildup of kinetic energy in these two cases as illustrated by equation (32); the first term $c_0 \cdot c\Delta m$ corresponds to Aristotle's forced motion, and the second term, $c_0 m\Delta c$ to Aristotle's natural motion obtained against release of gravitational energy via a reduction of the local velocity of light by Δc. Mathematically, the first mechanism corresponds to kinetic energy in special relativity, however, the increase of mass in the DU framework is not a consequence of velocity as it is in special relativity, but the mass contribution needed to obtain the velocity.

Special relativity does not apply to free fall in a gravitational field. Due to the postulated equivalence principle behind the general theory of relativity, the buildup of kinetic energy in free fall becomes identical with the buildup of kinetic energy in special relativity. Accordingly, free fall in GR is subject to buildup of relativistic mass equally with that in the SR. In the DU perspective it is obvious that the equivalence principle infringes the conservation of energy.

2.7.3. From Basic Concepts to Theory Structures

Philosophically, the main criterion for the performance of a physical theory is its ability to make nature understandable. Best theories rely on a minimum number of postulates, follow straightforward logic and mathematics, and give precise predictions to observations.

Figure 13 compares the buildup of present theory structures and the DU theory structure based on the overall energy balance in space. In both approaches the basic quantities are mass, distance, time and electric charge – the units of the basic quantities serve as the base units in the International System of Units.

The essential difference between force based and energy based physics comes from the "local orientation" of the "force physics", and the holistic or "system orientation" of the "energy physics". In force based physics, force is a postulated quantity and energy is a derived quantity as the integrated force. In force based physics, force interactions are studied as interactions between objects mediated by force carrier particles, gauge bosons. Inertial forces are linked to gravitational force by the equivalence principle. Force based physics relies on the relativity principle which allows fixing the state of rest to any of the interacting objects. The relativity principle establishes the local nature of force based physics.

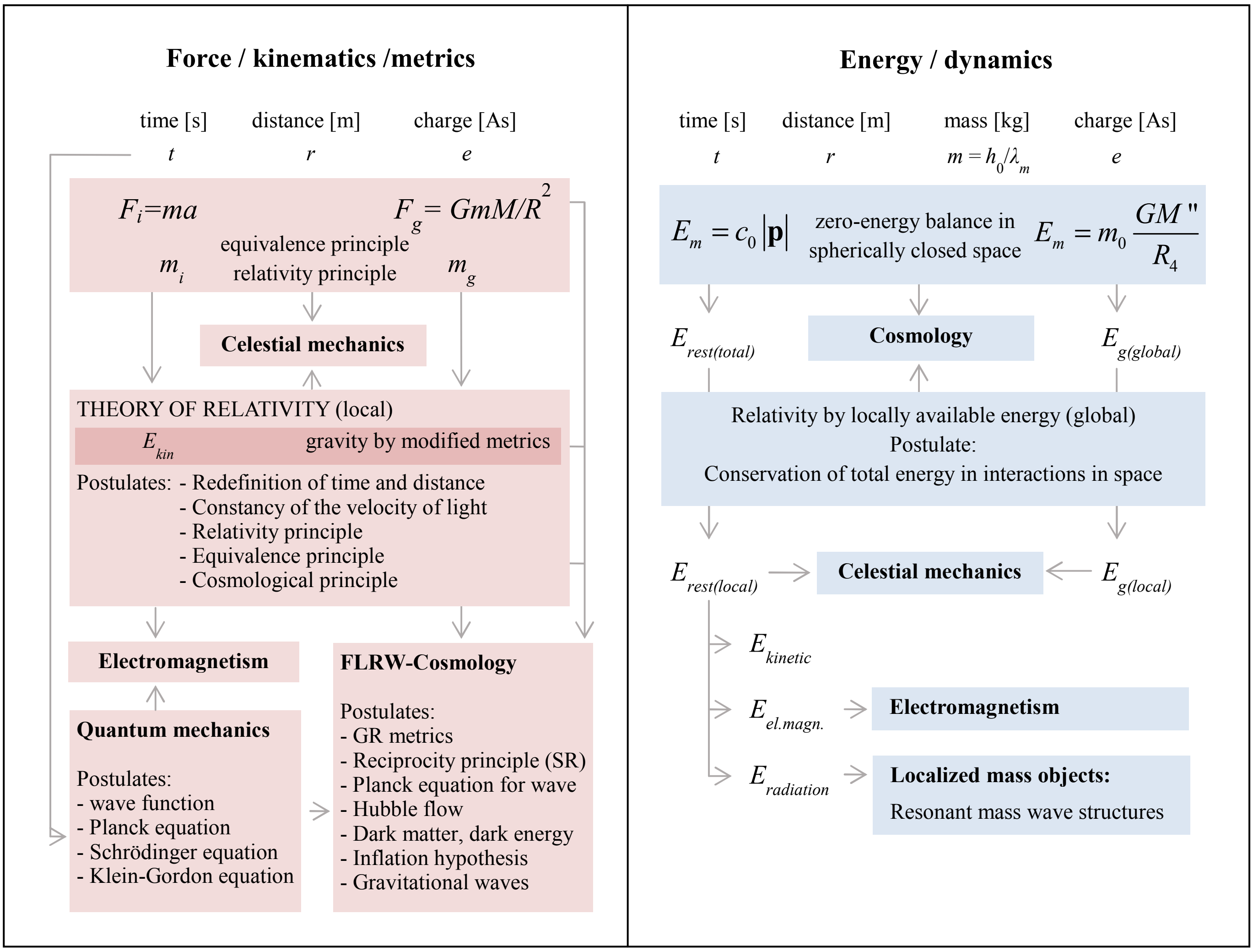


Figure 13. *The hierarchy of some central physical quantities and theory structures in contemporary physics based on force, kinematics and metrics, and in the Dynamic Universe based on conservation of zero-energy balance in spherically closed space.*

In energy based physics, energy is a postulated quantity and force is a derived quantity as the gradient of energy. As the first step, energy based physics requires the definition of the system studied. The basic postulates are the conservation of total energy in a system and a balance between the potential energy and the energy of motion. In energy based physics, the energy of motion is gained against the release of potential energy and vice versa.

Energy based physics follows the Aristotelian interplay of cause and effect, or actualization of potentiality. In the Dynamic Universe approach based on a zero-energy balance in space, the physical reality with all its manifold structures is described in terms of a system of nested energy frames. As an energy based theory DU allows a holistic view of physical reality. It relies on a minimum number of postulates and honors the universal coordinate quantities time and distance essential for human conception.

The comparison of contemporary physics and in the DU in Figure 13 illustrates the hierarchy of physical quantities, postulate bases, and theory structures in the two approaches.

Theory structures in contemporary physics follow the Galilean-Newtonian-Einsteinian path based on force as a basic quantity, the equivalence principle equalizing inertial force and gravitational force and the relativity principle leading to the description of relativity by modifying the coordinate quantities, time and distance. Quantum mechanics and the extension of general relativity to cosmology require postulate bases of their own; search for a unifying theory suffers from infringing postulates in different areas of physics.

Theory structures in the Dynamic Universe are based on a system approach starting from whole space. The DU relies on the zero-energy balance of gravitation and motion in space and the conservation of energy in all energy interactions in space. Relativity, cosmological predictions as well as a wave description of mass objects can be derived directly from the same basic postulates, which makes the DU a unifying theory structure. The philosophical requirement of making nature understandable is met with the intelligible picture of structured space, universal time and distance, and the concept of wavelike mass as a new approach to the description of quantum reality.

3. Radiation, Mass Wave and Mass Object

3.1. A Quantum of Radiation

A radio engineer can hardly think about a smaller amount of electromagnetic radiation than that emitted by a single oscillation cycle of a unit charge in a dipole [1,16]. When solved from Maxwell's equations, the energy emitted in a cycle of radiation in a dipole has the form of the Planck equation as E=A·hf. Such an analysis links the Planck constant to primary electrical constants and, as will be shown, confirms the relation of Planck constant to the velocity of light.

3.1.1. An antenna as a Quantum Emitter

Neither Max Planck nor any of his successors linked the famous equation $E=hf$ to Maxwell's equations describing the emission of electromagnetic radiation by a dipole.

Derivation of the Planck equation from Maxwell's equations reveals the essence of quantum as the energy emitted into a cycle of electromagnetic radiation by a single unit charge oscillation in an antenna. An emitting point charge can be studied as a one-wavelength Hertzian antenna in the fourth dimension; in the SR framework the line element in the fourth dimension is $ds = c\cdot dt$ which means that in one cycle $dt=1/f$, a point object has the extension $ds=c\cdot dt=c/f=\lambda$ in the fourth dimension. In the DU framework, the distance a point object moves in the fourth dimension in a cycle is equally $ds=c\cdot dt=\lambda$, Fig. 14.

By expressing the dipole solution in terms of the magnetic constant μ_0, and by relating the dipole length to the wavelength emitted, the energy of one cycle of electromagnetic radiation emitted is the product of power P and cycle time ΔT as

$$E_\lambda = P\cdot\Delta T = \frac{P}{f} = N^2\left(\frac{z_0}{\lambda}\right)^2\frac{2}{3}\left(2\pi^3 e^2\mu_0 c\right)f = N^2\left(\frac{z_0}{\lambda}\right)^2\cdot A\cdot h\cdot f \qquad (33)$$

where, in the last form, N is the number of unit charges oscillating in the dipole, z_0/λ the dipole length related to the wavelength emitted, and A a geometrical factor characteristic to the antenna (factor 2/3 in the first form applies to a Herzian dipole). For a single electron transition in one wavelength dipole, N=1 and z_0/λ =1. With A = 1.1043 equation (33) becomes identical with the Planck equation

$$E_\lambda = 1.1049\cdot\left(2\pi^3 e^2\mu_0 c\right)f = h\cdot f \qquad (34)$$

and links the Planck constant to the unit charge e, the magnetic constant μ_0, and the velocity of light as

$$h = 1.1049\cdot 2\pi^3 e^2\mu_0\cdot c \qquad (35)$$

Removing the velocity of light reveals an intrinsic Planck constant

$$h_0 = h/c = 1.1049\cdot 2\pi^3 e^2\mu_0 \quad [\mathrm{kg\cdot m}] \qquad (36)$$

and the energy of a quantum of radiation can be expressed as

$$E_\lambda = h_0 c\cdot f_e = h_0/\lambda_e\cdot c^2 = m_\lambda c^2 \qquad (37)$$

where the subscript "$_e$" in the wavelength and frequency refers to the emission wavelength and frequency.

As shown by (33), the energy of a cycle of radiation is proportional, not only to the frequency, but also the square of the number of electrons, N^2, oscillating in the emitter.

The fundamental nature of the decomposition of the Planck constant in (35) is reflected in the disclosure of the essence of the fine structure constant α, which now appears as a purely numerical factor without connections to any other physical constant,

$$\alpha \equiv \frac{e^2\mu_0 c}{2h} = \frac{e^2\mu_0}{2h_0} = \frac{e^2\mu_0}{2\cdot 1.1049\cdot 2\pi^3 e^2\mu_0} = \frac{1}{1.1049\cdot 4\pi^3} \simeq 1/37.0360 \qquad (38)$$

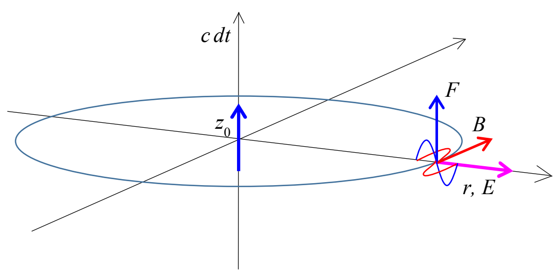


***Figure 14**. A point emitter like an atom can be described as a one-wavelength dipole, $z_0=c\cdot\Delta T=\lambda$, in the fourth dimension perpendicular to all three space directions. When solved from Maxwell's equations, the energy emitted into a cycle of radiation by a unit charge transition in the dipole has the form of Planck's equation $E=h\cdot f=(1.1049\cdot 2\pi^3 e^2\mu_0\cdot c)\cdot f$.*

3.1.2. Blackbody Radiation

Originally, the Planck equation, $E=hf$, was a postulated equation needed in the Planck radiation law for the explanation of the spectrum of blackbody radiation. The long wavelength part of the spectrum followed the Rayleigh-Jeans law based on harmonic waves and the equipartition principle in a blackbody cavity, the short wavelength part followed Wilhelm Wien's radiation law based on the distribution of the thermal energy of the emitters at the black body surface. Planck's radiation law combined the two, which, in principle, left open the question whether the spectrum and the quantization of radiation energy is a property of radiation or a property of the emission process. Einstein interpreted Planck's equation as a property of radiation, a photon, in his explanation of the photoelectric effect.

In fact, the Planck radiation law can be directly concluded from the antenna theory as a combination of two limiting mechanisms: At the long wavelength part the thermal energy, $kT>hf$, is enough to activate all the emitters, "the surface antennas", and the power density is limited by the emitter

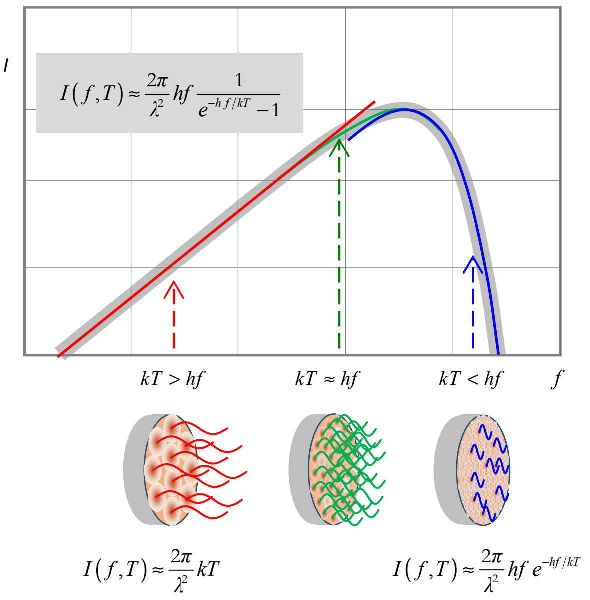


Figure 15*. Blackbody surface as antenna field. Antenna active area is related to the wavelength as $A_\lambda=\lambda^2/4\pi$, with emission intensity to half-space as $I_\lambda=1/A_\lambda=2\pi/\lambda^2$, which is exactly the Rayleigh-Jeans formula applying when all antennas are activated by the thermal energy, kT>hf. When only a part of antennas are activated as described by the Maxwell-Bolzmann distribution of the thermal energy, kT<<hf, the emission intensity follows Wilhelm Wien's radiation law. Max Planck's radiation law combines the two and covers also the transition region where kT≈hf.*

density. At the short wavelength part of the spectrum, where *kT<hf*, the limitation comes from the thermal energy available for the emitters, Fig. 15.

The "antenna" solution of black body radiation and the solution of Planck's equation from Maxwell's equations suggest unequivocally that the physical basis of quantizing is the emission and absorption processes.

3.1.3. The Essence of a Quantum

An important message of the linkage between the Planck equation and Maxwell's equations is that the "quantization" of electromagnetic radiation into apparent "photons" is a property of the emission process, not an intrinsic property of radiation. Quantization does not mean localization of radiation; it is a property of the emitter; radiation is emitted either as localized radiation purges, like that by a pulse laser or as a wide spatial wave front like many radio antennas.

With reference to the symmetry of Maxwell's equations, receiving of a quantum of radiation is a property of the absorption process; a quantum of radiation is received when the energy within a cycle of radiation in the "antenna active area" exceeds the energy needed to activate a single electron transition in the absorber.

A quantum of electromagnetic radiation described by the Planck equation, E=hf, is the energy which a single electron transition in the emitter transmits to a cycle of radiation. A quantum of radiation is detected when the energy of a cycle of electromagnetic radiation in the active area of the detector exceeds the energy needed to activate an electron transition in the detector. Like narrow band antennas, atomic absorbers (detectors) are wavelength selective rather than energy selective; the intensity of a cycle of radiation is not enough to result in absorption but also the wavelength of radiation shall match the characteristic wavelength of the absorber.

When propagating in space, a cycle of radiation conserves the energy it carries. When received by a receiver moving in the direction of the propagating radiation, the frequency of radiation is observed as reduced by the Doppler effect. The reduction of the frequency does not reduce the energy carried by a cycle of radiation – the wavelength is increased and the energy density is reduced. The same is true in the case of radiation received from cosmological distances; the expansion of space increases the wavelength observed but the energy carried by the wave is not affected by the expansion.

According to the standard cosmology model, the effect of the expansion of space on radiation propagating in space has been interpreted as reduction of the energy of radiation due to the increased wavelength – in addition to the reduction of energy density due to the Doppler effect [17]. Such an interpretation of the Planck equation as an intrinsic property of radiation means loss of energy due to the expansion of space.

In the standard cosmology, the loss of the energy of electromagnetic radiation due to "Planck dilution" is one of the factors resulting in the need for dark energy in the model.

3.2. Mass Object as a Resonator

As the counterpart of the mass equivalence of a radiation quantum or a cycle of electromagnetic radiation, the wavelength equivalence λ_m of mass *m* can be expressed as

$$\lambda_m = \frac{h_0}{m} \quad \left(= \lambda_{Comptom} = \frac{h}{mc} \right) \tag{39}$$

which is equal to the Compton wavelength in contemporary physics.

In the DU framework a mass object (particle) is described as a spherically symmetric resonator in 3-space. In spherically closed space, a quantity with symmetry in three space directions can be described as the quantity in the imaginary direction. The momentum of a resonator with standing waves built up of opposing waves and momentums in a space direction appears as the imaginary momentum, the rest momentum of the resonator in the imaginary direction

$$\mathbf{p}_{rest} = \mathbf{i}\, mc = \mathbf{i} \frac{h_0}{\lambda_m} \tag{40}$$

When a mass object is put into motion in space, the imaginary momentum will be accompanied by a real component equal to a net mass wave of the Doppler shifted front and back waves of the resonator,

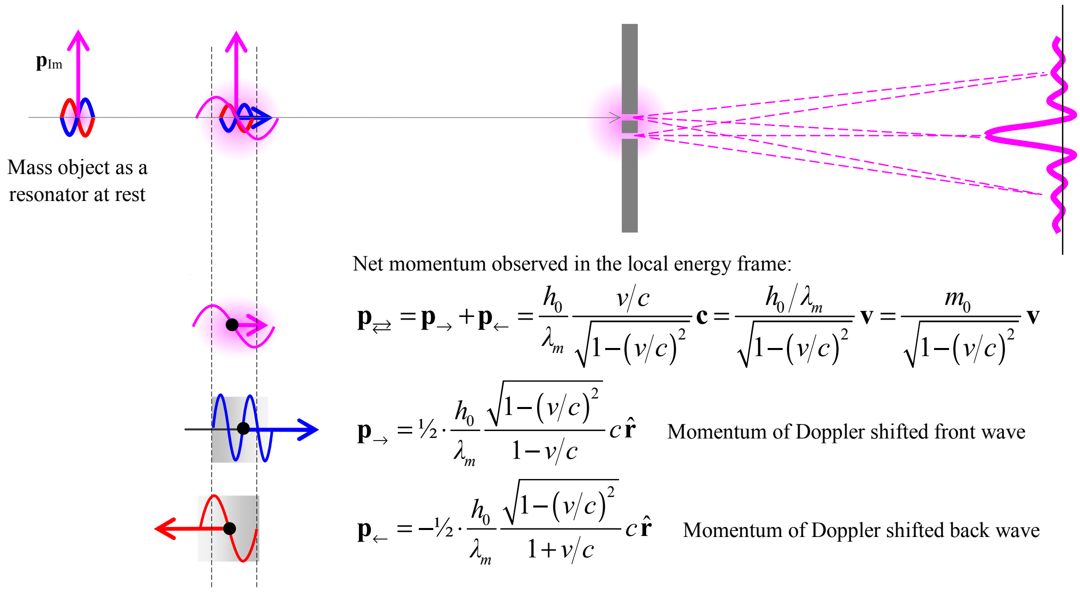


Figure 16.*(a). A mass object as one-dimensional standing wave structure moving at velocity v in a local energy frame. The momentum in space is the external momentum as the sum of the Doppler shifted front and back waves, which is observed as the momentum of a wave front propagating in the local energy frame in parallel with the propagating mass object. (b) The net momentum wave passing through the two slits results in an interference pattern on the screen.*

$$\mathbf{p}_{\rightleftarrows} = \mathbf{p}_{\rightarrow} + \mathbf{p}_{\leftarrow} = \frac{h_0}{\lambda_m}\frac{v/c}{\sqrt{1-(v/c)^2}}\mathbf{c} = \frac{h_0/\lambda_m}{\sqrt{1-(v/c)^2}}\mathbf{v}$$
$$= \frac{m_0}{\sqrt{1-(v/c)^2}}\mathbf{v} = \frac{h}{\lambda_{dB}} = \frac{h_0}{\lambda_{dB}}\mathbf{c} \tag{41}$$

As illustrated by equation (41), the net momentum wave of a mass object can interpreted as a mass wave corresponding to the wave equivalence of the "relativistic mass" $m_0\big/\sqrt{1-(v/c)^2}$ propagating at the velocity v of the moving mass object, or the de Broglie wave propagating at the velocity of light hidden in the conventional Planck constant.

In fact, the removal of the velocity of light from the Planck constant discloses the matter wave de Broglie was looking for: a wave does not disperse but follows the moving object.

The intrinsic Planck constant and the mass wave concept discloses the close connection between the Compton wave and the de Broglie wave.

Figure 16 illustrates the buildup of the momentum wave as the sum of the momentums of Doppler shifted back wave and front wave of a moving resonator. The momentum wave following the moving object is observed in the energy frame the velocity of the object is obtained. A hypothetical observer travelling with the object, observes the standing wave maintaining the rest momentum, which is reduced by the factor $1\big/\sqrt{1-(v/c)^2}$ by the motion.

An electromagnetic resonator behaves essentially in the same way as a mass wave resonator. The interferometer in the famous Michelson-Morley experiment can be reduced to a resonator moving in the Earth's gravitational frame and with the Earth's frame in the Solar frame. Again, an observer moving with the resonator, sees only the resonating wave – with opposite momentums equal in the resonator's frame.

3.3. Characteristic Energy States in Atoms

3.3.1. Principal States of the Hydrogen Atom

Applying the concept of a mass wave, the principal energy states of an electron in hydrogen-like atoms can be solved by assuming a resonance condition of the matter wave of electron, the de Broglie wave, in a Coulomb equipotential orbit around the nucleus. Applying the unified expression of the Coulomb energy of Z electrons at distance r from the nucleus can be written as

$$E_{Coulomb} = -Z\frac{q^2\mu_0}{2\pi r}c_0 c = -Z\alpha\frac{\hbar_0}{r}c_0 c \tag{42}$$

where $\hbar_0 = h_0/2\pi$ is the *reduced intrinsic Planck constant*. Applying the wave number $k = 2\pi/\lambda$ the resonance condition, for an electron's de Broglie wave number is $k_{dB} = n/r$, and the sum of kinetic energy and the Coulomb energy becomes

$$E_n = E_{kin} + E_{Coulomb} = c_0\hbar_0 k_m c\left[\sqrt{1+\left(\frac{n}{k_m r}\right)^2} - 1 - \frac{Z\alpha}{k_m r}\right] \tag{43}$$

The solution of (43) for different values of n is presented in Fig. 17. The minima of E_n for principal quantum numbers n are

$$E_{Z,n} = -mc_0 c\left[1-\sqrt{1-\left(\frac{Z\alpha}{n}\right)^2}\right] \approx -\left(\frac{Z}{n}\right)^2\frac{\alpha^2}{2}mc^2 \tag{44}$$

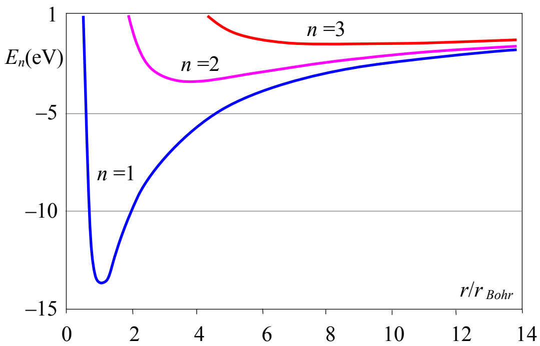


Figure 17. *Total energies given by equation (43) for n = 1, 2, 3. Each energy state is continuous, but the minima and the corresponding energies are the same as in solutions given by quantum mechanics.*

where the fist expression is the exact, "relativistic" solution. The second expression, as an approximation of the first expression, is equal to the solution based on Schrödinger's equation.

The important message of the hydrogen atom solution is that quantum states are not intrinsically discrete states but energy minima of resonant states. The algebraic wave number equation (43) provides the principal energy states; for obtaining the fine structure states the mass wave shall be expressed in terms of a wave equation for solving all associated spherical harmonics.

3.3.2. Characteristic emission and Absorption Frequencies

The characteristic emission and absorption frequencies are determined by the energy differences between the states of the electron undergoing transition. As illustrated by (44) energy states are proportional to the rest energy of electron and a function of the quantum numbers. In the DU framework the rest energy is a function of the local state of gravitation and motion which makes also the characteristic frequency a function of gravitation and motion as

$$f_{(n1,n2)} = \frac{\Delta E_{(n_1,n_2)}}{h_0 c_0} \sim \frac{m_0 c_0}{h_0} \prod_{i=1}^{n} \left(1-\delta_i\right) \sqrt{1-\beta_i^2} \qquad (45)$$

In a local energy frame like the Earth gravitational frame the (45) reduces into form

$$f_{(\delta,\beta)} = f_{(0,0)} \left(1-\delta\right) \sqrt{1-\beta^2} \qquad (46)$$

where $f_{(0,0)}$ is the reference frequency of the ECI (Earth Centered Inertial) frame of an oscillator at a rest (excluding the rotation of the Earth), far from the Earth where $\delta \approx 0$. Equation (46) corresponds to GR equation (31) applied to Earth satellite clocks. In near Earth applications the predictions of (46) and (31) are equal down to the 18th decimal.

In a laboratory frame, at a fixed gravitational potential on the rotating Earth (46) reduces into form equal to the prediction of special relativity,

$$f_{(\beta)} = f_{(0)} \sqrt{1-\beta^2} \qquad (47)$$

where $f_{(0)}$ is the frequency of an oscillator at rest in the laboratory and $f_{(\beta)}$ an oscillator moving at velocity $\beta=v/c$ in the laboratory frame.

3.3.3. Effect of the Expansion of Space

As shown by (45), the characteristic frequency is proportional to the rest momentum of electron, which means that the frequency decreases in direct proportion to the decreasing velocity of light with the expansion of space. The characteristic wavelength,

$$\lambda_{(n_1,n_2)} = \frac{c}{f_{(n_1,n_2)}} \sim h_0 \Big/ m_0 \prod_{i=1}^{n} \sqrt{1-\beta_i^2} \qquad (48)$$

however, is independent of both the expansion of space and the local gravitational state. The wavelength of radiation propagating in space increases in direct proportion to the expansion of space. Wavelengths observed from distant space are therefore redshifted in comparison to wavelengths from corresponding electron transitions at the time of the observation. The wavelength of characteristic radiation is directly proportional to the atomic radius or the Bohr radius, which is also conserved in the expanding space.

3.3.4. Gravitational Red/Blue Shift

The gravitational shift of electromagnetic radiation emitted by a radiation source at different altitudes was confirmed for the first time by measurement of the Mössbauer effect in a test setup where the source and the absorber were taken to different altitudes [18,19,20]. A famous experiment on gravitational blue shift was performed in 1976 by sending a hydrogen maser to an altitude of 10,000 km in a nearly vertical trajectory [21].

In the GR framework, the velocity of light and the proper frequency of an oscillator are independent of the gravitational field and accordingly the altitude. The blue shift of radiation from an oscillator at elevated altitude is explained as a change in frequency of the radiation when passing to a lower altitude (by gaining energy in the fall) and compared to the frequency of a reference clock.

In the DU framework, both the velocity of light and the frequency of an oscillator at elevated altitude are increased. The emission wavelength, $\lambda=c/f$, is independent of the altitude. When transferred to a reference oscillator at lower altitude the increased frequency of the emitted radiation is conserved and the wavelength is shortened due to the slower velocity of light at the lower altitude.

Within the experimentally achieved accuracies, the numerical predictions for near Earth experiments are the same in the GR and DU frameworks. The DU interpretation is confirmed by comparing cumulative readings of atomic clocks at different altitudes.

4. The Dynamic Cosmology

In the DU, the precise geometry, dynamics and energy development of space allow the derivation of precise mathematical expressions for redshifts, optical distances, angular sizes, and apparent magnitudes of cosmological objects without additional parameters.

4.1. The Dynamics of Expansion

4.1.1. Development of Expansion

In the DU, the dynamics of the expansion of space is determined from the zero-energy balance of motion and gravitation expressed by equation

$$M_\Sigma c_0^2 - \frac{GM_\Sigma M''}{R_4} = 0 \tag{49}$$

where M_Σ is the total mass in space, $M''=0.776\cdot M_\Sigma$ the mass equivalence of the total mass when concentrated to the center of the 4-sphere, c_0 the 4-velocity of homogeneous space, and R_4 the 4-radius corresponding to the Hubble radius in standard cosmology. Velocity c_0 can be solved (49) as

$$c_0 = \pm\sqrt{\frac{GM''}{R_4}} = \pm\sqrt{\frac{G\cdot 0.776 M_\Sigma}{R_4}} \tag{50}$$

which also determines the velocity of light in space. Assuming Hubble constant H=70 (km/s)/Mpc, the current value of R_4 is $14.0\cdot 10^9$ light years, and the total mass in space is $M_\Sigma = 2.30\cdot 10^{53}$ kg. As the surface of a 4-sphere, the volume of space is $V=2\pi^2 R_4^3$, resulting in average mass density $\rho=5.0\cdot 10^{-27}$ [kg/m^3]. Mass density in zero-energy space corresponds to the Friedman critical mass density, which due to the different volume expression ($V=4/3\cdot\pi R^3$) obtains the value $9.2\cdot 10^{-27}$ [kg/m^3]. In the DU, the velocity of the expansion, $c_0=dR_4/dt$, decreases with increasing of R_4. The age of expanding space today is related to the current values of R_4 and c_0 as

$$t_{now} = \frac{2}{3}\frac{R_{4(now)}}{c_{0(now)}} = \frac{2}{3}\cdot 14\cdot 10^9 \text{ years} \approx 9.3\cdot 10^9 \text{ years} \tag{51}$$

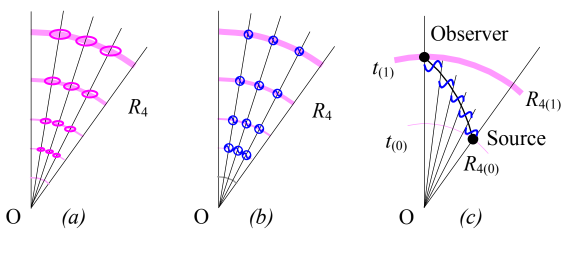


Figure 18. (a) Dimensions of galaxies and other gravitationally bound systems expand in direct proportion to the expansion of space. (b) Localized objects bound by electromagnetic forces conserve their size. The characteristic wavelength emitted by atomic objects is conserved. (c) The wavelength of electromagnetic radiation propagating in space increases in direct proportion to the expansion of space.

which is less than the linear estimate of $14.0\cdot 10^9$ years of the standard cosmology model.

The rate of physical phenomena like nuclear decay is related to the velocity of expansion. Accordingly, age estimates are based on radiometric dating are subject to scaledown due to the higher decay rates in the past.

4.1.2. Expanding and Non-Expanding Objects

In the standard cosmology model, galaxies and other gravitationally bound systems conserve their dimension in the course of the expansion of space as originally suggested by de Sitter in 1931 [22].

In DU space, all gravitationally bound systems expand in direct proportion to the expansion of whole space. Atoms and, in general, structures bound by electromagnetic energy conserve their dimensions in the course of the expansion. The characteristic emission wavelengths are directly proportional to the Bohr radius, or the size of atoms, which means that the emission wavelength is conserved. The wavelength of electromagnetic radiation propagating in space lengthens in direct proportion to the expansion of space, which means that characteristic wavelengths are observed redshifted as compared to the corresponding characteristic wavelength at the time of observation, Fig. 18.

4.2. Observations in DU Space

4.2.1. Physical and Optical Distance

The physical distance, referred to as the co-moving distance in the standard model, of an object in space is the length of the arc between an object and the observer

$$D_{phys} = R_4\cdot\theta \tag{52}$$

Physical distance is not directly observable because the optical information is transferred at the velocity of light. Due to the equal velocities of space in the fourth dimension and the propagation velocity of light in space, the length of the optical path in space is equal to the increase of the 4-radius during the transmission, Fig. 19. Optical distance, the length of the light

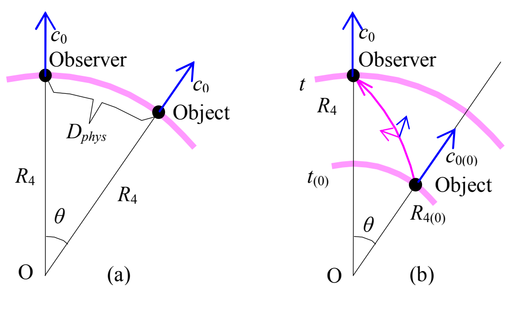


Figure 19. (a) The classical Hubble law corresponds to Euclidean space where the distance of the object is equal to the physical distance, the arc D_{phys}, at the time of the observation. (b) When the propagation time of light from the object is taken into account the optical distance is the length of the integrated path over which light propagates in space in the tangential direction on the 4-sphere. Because the velocity of light in space is equal to the expansion of space in the direction of R_4, the optical distance is $D= R_4-R_{4(0)}$, the lengthening of the 4-radius during the propagation time.

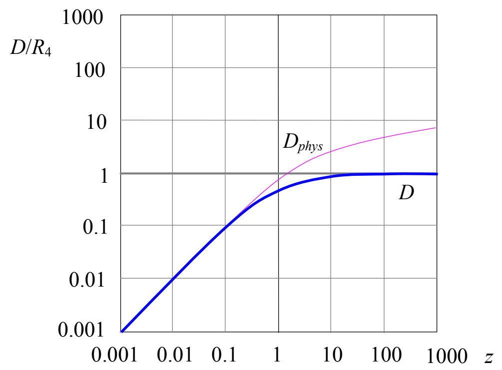


Figure 20*. Distances in the Dynamic Universe. Optical distance D and physical distance D_{phys} as functions of the red shift. At very high redshifts the optical distance approaches the R_4 corresponding to the Hubble radius R_H in the FLRW space.*

path in space, can be expressed in forms,

$$D = R_4\left(1-e^{-\theta}\right) = R_4\frac{z}{1+z} \tag{53}$$

where θ is the angular distance of the object along the spherical space, and z the redshift defined as

$$z = \frac{R_4 - R_{4(0)}}{R_{4(0)}} = \frac{\lambda-\lambda_0}{\lambda_0} \quad \left(= e^{\theta}-1\right) \tag{54}$$

where R_4 is the 4-radius at the time of observation and $R_{4(0)}$ the 4-radius when the light information was sent. Figure 20 illustrates the physical and optical distances in DU space.

Figure 21 gives an overview of the distances in the standard cosmology model. The co-moving distance D_C corresponds closest to the physical distance, and the light-time distance D_{LT} the optical distance in the DU.

All distances are subject to experimental mass density parameters Ω_m and Ω_Λ defining the share of ordinary mass with pulling gravitation and the dark energy with pushing gravitation. The sum of the two density parameters defines the shape of FLRW-space. The currently preferred density parameter values, $\Omega_m\approx 0.27$ and $\Omega_\Lambda\approx 0.73$, Fig.21(b), bring the co-moving distance D_C and the light-time distance D_{LT} closest to the corresponding DU predictions in Fig. 20.

4.2.2. Angular Size of Objects Observed

In standard cosmology, local gravitational systems do not expand with the expansion of space. The angular diameter of distant objects like galaxies is based on angular size distance, which means the distance of the object at the time when the optical information left, Fig. 21. Such a choice is based on the assumption that the optical angle is conserved during expansion. Theoretically, it is justified by the reciprocity theorem relying on the theory of relativity [23]. Conservation of the optical angle means that the observed angular size of objects with redshift $z > 1$ increases with increasing distance in standard cosmology.

In the DU, all gravitationally bound systems expand in direct proportion to the expansion of space and the observed angular sizes of objects are calculated from the optical distance. There is no basis for reciprocity in DU space; the expression for angular diameter is

$$d(z) = d_R/(1+z) \tag{55}$$

which means Euclidean appearance of distant space – in perfect agreement with observations [24], Fig 22. The red curves in the figure illustrate the effect of the increasing

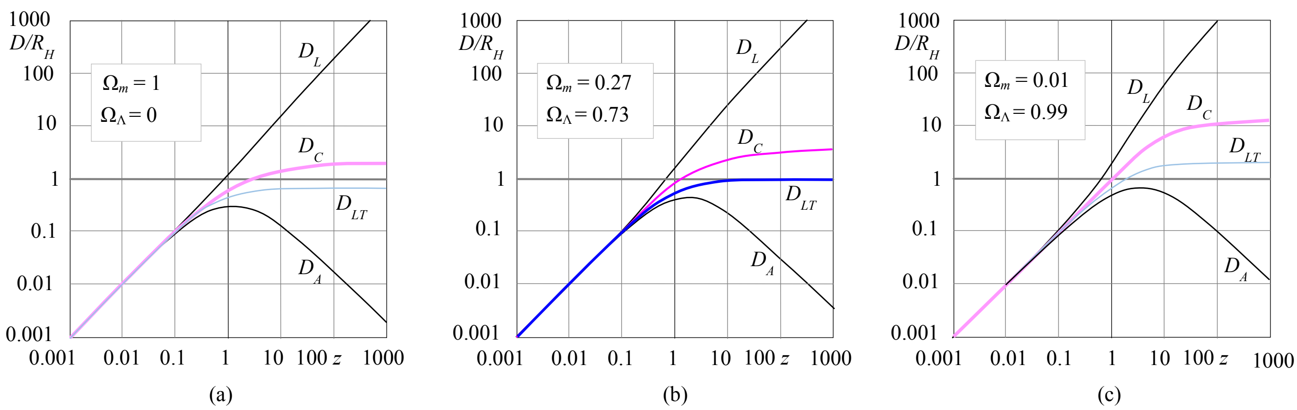


Figure 21*. Central definitions of distances in FLRW-space for three combinations of mass density and dark energy. Each case assumes the "flat space" condition which means that the sum of the two density parameters is equal to one, $\Omega_m + \Omega_\Lambda = 1$. The Co-moving distance D_C, which means the physical distance at the time of observation, is obtained from Friedmann's solution to the field equations of the general theory of relativity. The Light-time distance, D_{LT} is the length of the light path from the object to the observer in the expanding space. In principle, the Light-time distance approaches the Hubble radius R_H at very high redshifts that occurs in case (b), which has the currently preferred values of the density parameters, $\Omega_m = 0.27$ and $\Omega_\Lambda = 0.73$. The Angular size distance D_A is obtained by dividing the co-moving distance D_C with the expansion factor (1+z), which means the distance of the object at the instant the light is left from the object. The Luminosity distance D_L is obtained by multiplying the co-moving distance D_C by the expansion factor (1+z), which gives the effect of the increased wavelength on the dilution of the power density. The power density of radiation is proportional to the square of the inverse of the Luminosity distance D_L.*

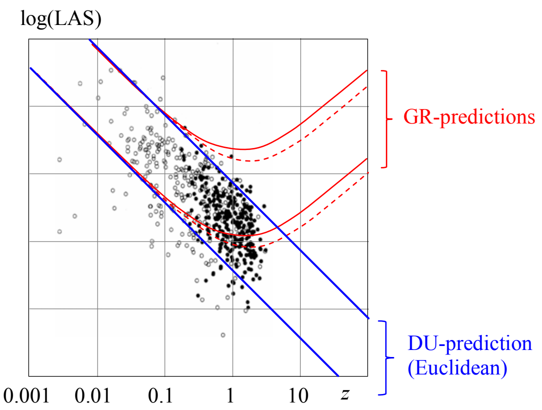


***Figure 22**. Dataset of the observed Largest Angular Size (LAS) of quasars and galaxies in the redshift range 0.001 < z < 3 [24]. Open circles are galaxies, filled circles are quasars. Observations are compared with the DU prediction (blue lines) and the FLRW prediction (red curves) with Ω_m= 0 and Ω_Λ = 0 (solid curves), and Ω_m= 0.27 and Ω_Λ= 0.73 (dashed curves).*

angular size which results in major deviation of the GR predictions from observations. It can also be seen that the recently introduced dark energy has minor effect on the GR predictions.

4.2.3. Apparent Magnitude

In standard cosmology, the dilution of the power density of radiation is linked to the angular size D_A distance and the co-moving distance D_C as

$$F_{FLRW} = \frac{L}{4\pi D_A^2}\frac{1}{(1+z)^4} = \frac{L}{4\pi D_C^2}\frac{1}{(1+z)^2} \tag{56}$$

where L is the luminosity of the radiation source. The two expansion factors (1+z) in the last form come from the Doppler dilution and "Planck dilution" of the radiation received.

In his original work Tolman [17] states that the energy dilution "evidently" occurs due to the Planck equation. Tolman's conclusions were confirmed by several authors in the 1930s [25,26,27]. As shown by (56) the areal dilution of radiation is linked to the co-moving distance, which is the physical distance between the object and the observer at the time of observation.

In the DU, the mass equivalence carried by a quantum of radiation is conserved in the course of the expansion of space which links the Planck equation to emission and emission wavelength. Accordingly, there is no place for "Planck dilution" of radiation in the DU. The areal dilution in DU is linked to the optical distance, which is the actual distance travelled by the optical information to the observer,

$$F_{DU} = \frac{L}{4\pi D^2}\frac{1}{(1+z)} = \frac{L}{4\pi R_4^2}\frac{z+1}{z^2} \tag{57}$$

where the last form is obtained substituting (53) for the optical distance D. The apparent magnitude based on (57) obtains the form

$$m = M + 5\log\frac{R_0}{d_0} + 5\log z - 2.5\log(1+z) \tag{58}$$

which means the bolometric magnitude observed (without instrumental and atmospheric corrections).

Equation (58) is the DU replacement of apparent magnitude in standard cosmology,

$$m = M + 5\log\frac{R_H}{D_0} + 5\log\left[(1+z)\int_0^z \frac{1}{\sqrt{(1+z)^2(1+\Omega_m z) - z(2+z)\Omega_\Lambda}}dz\right] \tag{59}$$

Equation (59) of the standard cosmology model applies to observed magnitudes corrected with K-correction. In addition to instrumental factors, the K-correction converts the observed magnitudes to the "emitter's rest frame". The concept of "emitter's rest frame" is irrelevant in the DU. To make the DU prediction compatible with K-corrected observations, a term 5log(1+z) shall be added to the magnitude in equation (58) which converts (58) into form

$$m = M + 5\log\frac{R_0}{d_0} + 5\log z + 2.5\log(1+z) \tag{60}$$

4.2.4. Observations and the K-correction

In present practice, the observed bolometric magnitudes are corrected with K-correction, which is said to return the observed magnitudes to the emitter's rest frame. Originally, the K-correction was used for correcting instrumental factors and atmospheric disturbances. Modern multichannel photometry allows matching of the wavelength bands to the redshift of the incoming radiation, which allows practically bolometric detection. As shown in [1], the K-correction is needed to match observations to the predictions of the standard cosmology model including the "Planck-dilution" and the areal dilution based on the (inevitably oversized) co-moving distance.

In the DU prediction, the areal dilution is based on the optical distance, which is the actual length of the light path. The DU honors the conservation of energy, which excludes the "Planck-dilution". As a result, the DU prediction for the magnitude matches directly, with high accuracy, to the observed bolometric magnitudes.

Figure 23 compares the DU and FLRW predictions to K-corrected "high-confidence" magnitudes of supernovas observed with the Hubble Space Telescope [28]. As illustrated in Fig. 23, and confirmed by a chi-squared test [29], the DU prediction fits with the observations at least as well as the standard cosmology prediction.

The DU prediction of magnitudes does not require additional parameters like the dark energy. It does not predict accelerating expansion either. The dynamics of expansion is determined by the zero-energy balance of motion and gravitation in the spherically closed structure, which means that expansion decelerates because the expansion works

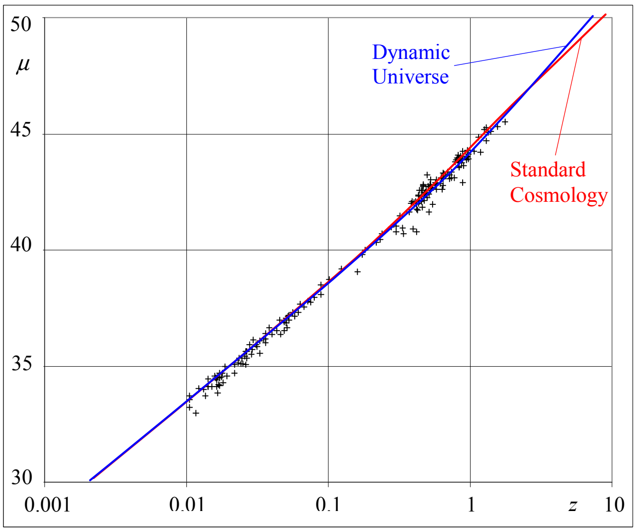


***Figure 23**. Distance modulus $\mu = m - M$, vs. redshift for Riess et al. "high-confidence" dataset and the data from the HST, Riess [28]. The optimum fit for the standard model prediction (59) is based on $\Omega_m = 0.27$ and $\Omega_\Lambda = 0.73$. The difference between the DU prediction (60) and the prediction of the standard model is very small in the red-shift range covered by observations, but becomes meaningful at redshifts above $z > 3$.*

against the gravitation of the structure.

4.3. The BigBang and the Cosmic Microwave Background

4.3.1. Turn of Contraction into Expansion

The BigBang replacement in the DU is a singularity, the turn of the contraction phase into the expansion. It is characterized by an extreme excitation of the energies of motion and gravitation related to the dynamics of space in the fourth dimension. Considering the wave nature of mass, singularity in the DU shall not be considered as an instant zero dimension point-like state but a finite minimum distance turning the contraction into expansion. Singularity does not necessarily mean an extreme temperature – primarily, it means excitation of the rest energy of mass against the gravitational energy released.

In its basic state, mass as the substance for the expression of energy may be considered as a non-structured wave propagating in the fourth dimension, which means closest to the characteristics of dark matter. Structured material in DU space is described in terms of resonant mass wave structures. Favorable conditions for nucleosynthesis, and more generally for conversions of matter, material and electromagnetic radiation, can be seen both following the singularity and continuously in the vicinity of local black holes all over the spherically closed space.

The DU does not assume conditions as in inflation in standard cosmology. It does not assume a Cosmic Microwave Background originating from early expanding space.

4.3.2. The Cosmic Microwave Background (CMB)

In the DU perspective, a major problem in the explanation of the CMB in the standard cosmology model is the infringement of the conservation of energy. The standard cosmology explanation means that about 10% of the total energy in space has been lost due to the redshift of the CMB.

The Cosmic Microwave Background (CMB) radiation is often referred to as one of the strongest evidences supporting the BigBang model. CMB consists of electromagnetic radiation with the spectrum corresponding to the spectrum of black body radiation.

The frequency spectrum and the energy density of CMB correspond, with high accuracy, to black body radiation within a cavity at 2.725 K. The precise power density of CMB is an indication that the radiation is in continuous equilibrium with substance at 2.725 K. In standard cosmology, CMB is interpreted as afterglow of the BigBang redshifted by $z \approx 1100$.

The characteristic power density of blackbody radiation is proportional to the 4^{th} power of the blackbody temperature and inversely proportional to the 4^{th} power of wavelengths emitted. Conservation of the energy of radiation propagating in expanding space requires that the power density of radiation dilutes in direct proportion to the increase of volume, inversely proportional to the 3^{rd} power of the wavelength of the radiation. Like in magnitude predictions in the standard cosmology model, the Planck equation has been applied as an intrinsic property of radiation which makes the power density of radiation dilute inversely proportional to the 4^{th} power of wavelength. The present energy content of CMB is estimated to be about 0.0001 of the total energy in space. According to the standard interpretation, the CMB energy has been about 10% of the total energy when the radiation was emitted, which means that CMB has lost about 10% of the total energy in space.

In the DU perspective, the observed microwave background is blackbody radiation in thermal equilibrium with the surrounding space.

5. Summary

As a holistic approach to physical reality, the Dynamic Universe starts from the whole and devolves down to the local. It is primarily an analysis of the energy resources available for the manifestation of physical processes and structures in space. The Dynamic Universe relies on a zero-energy balance in absolute time and universal distances as the coordinate quantities essential for human conception.

The Dynamic Universe means major change in the paradigm and a definite cancellation of the cornerstones of both the special and the general theory of relativity: the relativity principle, the equivalence principle and the constancy of the velocity of light. For describing "relativistic effects" we can choose either a kinematic approach with coordinate transformations, like in the relativity theory – or a dynamic approach in universal coordinates, like in the Dynamic Universe, where relativity is expressed in terms of locally available energy. In the DU, clocks in motion do not run slower due to coordinate transformations or slower flow of time but because they share the available energy between the energy allocated to the motion in space and the energy running the oscillator of the clock.

The Dynamic Universe means a major, inevitable reorientation to the picture of reality. Copernicus freed us from the Ptolemaic world picture by recognizing the structure of the planetary system and an observer's motion in the system. The DU recognizes the structure of whole space and the observer's motion, not only in the planetary system and the Milky Way but also with the whole three dimensional space in the fourth dimension. Recognition of the structure of space makes it possible to study the whole of space as an energy system, and link the dynamics in space to the dynamics of whole space. Such an approach shows relativity as a natural consequence of the conservation of the overall energy balance in space – without a need to modify coordinate quantities, time and distance.

Localized objects in spherically closed space are described as resonant mass wave structures, where quantum states appear as energy minima of the resonant energy states. The rest energy of localized objects is counterbalanced by the gravitational energy arising from the rest of space.

The dynamic Universe model relies on only a few postulates that apply in all areas of physics. The predictions of the DU for most physical phenomena are essentially the same as those in contemporary physics. Yet they are based on very different theory structures and imply a profound change in the picture of reality. Differences in predictions can only be observed at the extremes, at cosmological distances and in the vicinity of local singularities in space. Importantly, the different DU-predictions fit better with observations than do the predictions based on standard cosmology.

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