

Black Holes as the Source of All Matter and Radiation in the Universe

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Abstract An in-depth study of general relativity has led to the development of a theory, CBU for the continuously breeding universe, in which the universe emerges from a quantum fluctuation and continues to expand due to the inflow of new matter, foremostly electrons and positrons. According to a novel model for black holes, a continuous inflow of matter prevents the black holes from becoming singularities, the contraction pressure is counteracted by the expansion pressure. The study shows that the gravitational energy gap between the event horizon and the inner photon sphere of a black hole is the source of incoming real matter from a QED vacuum foam of virtual particles. The calculated CBU results are in good agreement with current observations.

Keywords: black holes, general relativity, quantum mechanics, Schrödinger equation, Heisenberg uncertainty

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1. Introduction

In 1937 the prominent British physicist Paul Dirac published his Large Number Hypothesis (LNH), [1]. Still in the 70ies he was certain that there is a 'continuous creation' and that G varies with time, [2]. In 1973 E. P. Tryon wrote an article in *Nature* wherein he suggested that the universe was initiated by a positron-electron quantum fluctuation, [3]. In 1994 Alan Guth, the physicist behind the inflation theory, suggested that the total energy of the universe is zero. Matter and radiation provide the positive part, while the potential energy of gravity forms the negative part, [4].

This article is a continuation of an in-depth study, the aim of which is to prove that Dirac's LNH theory has an anchorage in general relativity and depicts the universe in accordance with recent satellite data. The CBU theory was presented by the author in ref. [5]. Among other things the theory suggests that an inherent acceleration causes a Coriolis effect, which explains some strange features of galaxy rotational movements, without the introduction of dark matter.

A more recent article shows that the Einstein Field Equation can be formulated in a more concise form $G_{\mu\nu}=T_{\mu\nu}$, wherein $G_{\mu\nu}$ is the Einstein tensor and $T_{\mu\nu}$ is the energy-momentum tensor [6]. Quantum mechanics appears to have a crucial impact on the universe expansion. A solution to the Schrödinger equation of the initial event offers an explanation to the excitation of real-world positron-electron pairs from the QED vacuum foam. The energy of the universe is confined to matter and radiation, neither dark energy nor dark matter is required. However,

a certain part of the quantum foam may be considered as virtual dark energy, which in an accumulated form corresponds to the dark energy of the Λ CDM theory.

The present article introduces an alternative theory of black holes. Instead of singularities they are real objects, wherein the inflow of electrons and positrons balances the shrink effect. The same development scheme of the *universe black hole* is followed by *galaxy black holes*, with one exception, instead of expanding they increase the energy density.

2. Outline of a Theory

Black holes are of crucial importance when looking for a logical and physically comprehensive picture of the expanding universe. Here is an outline of the main features of the theory.

The universe starts with the quantum fluctuation event, an electron and a positron jump into existence and simultaneously create the space necessary for their existence. This is the inside of the *universe black hole*. The negative gravitational potential energy between particles equals the energy of the matter. The Newtonian gravitational constant G_N is not a constant, but a parameter G inversely proportional to the curvature of space. This is also proclaimed by Albert Einstein in his original work on General Relativity [7,8], however, he did not know that the universe was expanding and that the curvature was changing. Due to a high value of G in the initial state (birth of the universe) the Planck length and Planck time were very large and allowed a fast inflow to take place. In the beginning the expansion speed is low and the acceleration high, but over time the expansion speed

approaches the speed of light while the acceleration decreases asymptotically towards zero. The inflow of electrons and positrons is responsible for the large-scale expansion, the inverse value of the curvature radius is responsible for the acceleration. It was shown in ref. [6] that the curvature radius r equals the radius of the observable universe and is half the inner photon radius (the boundary that prevents photons from leaving the black hole).

In the primordial universe electrons and positrons annihilate into entangled photons. We postulate that the EM energy of entangled photon pairs has no impact on the gravitational parameter G . When a half of the total energy is confined in entangled pairs, the Schwarzschild radius limit is exceeded, and a transition occurs, wherein matter form a multitude of "small" black holes and the photons are liberated into the CMB (cosmic microwave background) radiation. The universe itself remains a low-density black hole.

After the transition, the black holes (*galaxy BHs*) will form the seeds for the future galaxies. It will be demonstrated that in parallel with a uniform increase electrons and positrons, baryonic matter (protons and antiprotons) is induced outside the Schwarzschild horizon of the *galaxy BHs*, the production of galaxy matter has begun. The theory will not go into the physics involved in the process of changing antiprotons to neutrons and electrons and further into atoms.

3. Geometry and Fundamental Equations

We regard the universe as a black hole, where light is confined to the whole of space, there is no space on the outside, at least we have no means to connect to that world. Bernard McBryan has studied black holes of different modes, [9]. He states that one could live in a low-density black hole without knowing it. According to McBryan our universe could be a "classical finite height black hole", wherein the inner photon sphere radius is half the Schwarzschild radius r_s . This is an important ruling; we use the Schwarzschild event horizon to determine the hypothetical outer radius r_u of the universe

$$r_u = \frac{1}{2}r_s = \frac{GM_u}{c^2}, \quad (1)$$

where M_u is the mass of the universe (actually the total energy W_u divided by c^2), G is the gravitational parameter and c the velocity of light. Equation (1) is familiar from several significant proposals, most important those by Sciama, [10], Brans and Dicke, [11] and Dirac, [2]. A simple formula also hints in the same direction: Think of all mass concentrated to the centre, how far distance from the centre is required to create a new mass m , which equals the gravitational potential energy? Answer: $mc^2 = GM_u m/r_u$, i.e. eq. (1). However, the best argument in favour of eq. (1) is the inner photon sphere radius, $hf = GM_u(hf/c^2)/r_u$.

We regard $r_B = GW_B/c^4$ (photon radius) as a valid definition of the ordinary black hole radius, W_B is the total energy confined in the black hole.

There is a problem to visualize the General Relativity 4D space-time into 3D. In the paper on the cosmological constant of 1917, (8), Einstein writes "the points of this hyper-surface form a three-dimensional continuum, a spherical space of curvature R ". He also defines a constant $k = 8\pi G/c^2$, which scales the energy-momentum tensor $T_{\mu\nu}$. This constant is directly connected to a 3D sphere.

Figure 1 shows a visualization of the 3D universe, where r_u is the virtual outer radius. It is useful to think of the universe as a sphere, the volume and outer area of which are

$$V_u = \frac{32\pi r^3}{3}, \quad (2)$$

$$A_u = 16\pi r^2. \quad (3)$$

$r = r_u/2$ is the radius of the observable universe. $r = ar_0$ is the most important variable of this study, a is the scale factor, r_0 the present value of r .

Based on eq. (1) we state as our principal postulate the following equation

$$\frac{G}{r} = \frac{2c^4}{W_u}, \quad (4)$$

where $W_u = M_u c^2$, the total real energy (matter and radiation) of the universe.

At the initial event, when the first positron-electron pair appears, we have

$$\frac{G_i}{r_i} = \frac{2c^2}{2m_e} = \frac{c^2}{m_e}, \quad (5)$$

where G_i is the initial gravitational parameter, r_i the radius and m_e (W_e/c^2) the electron rest mass. The energy equation is obtained by assuming a πr_i separation, in curved space, between the particles

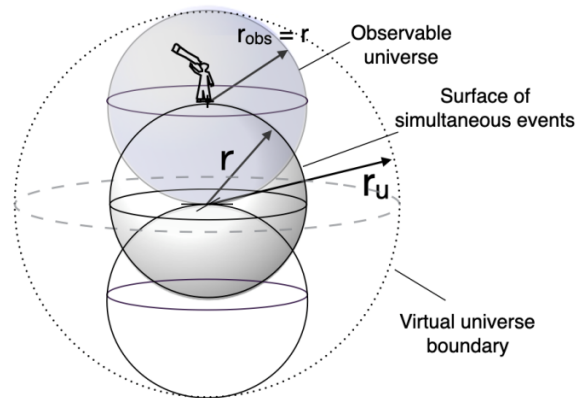


Figure 1. Definitions related to the spherical 3D image of the universe, cf. ref. [6]

$$2m_e c^2 = G_i \frac{m_e^2}{\pi r_i} + \frac{e^2}{4\pi\epsilon_0(\pi r_i)}, \quad (6)$$

where e is the electron charge and ϵ_0 is the vacuum permittivity. The curvature radius of the initial universe is

$$r_i = \frac{e^2}{4\pi\epsilon_0 m_e c^2 (2\pi - 1)} = 0,5333790410^{-15} m. \quad (7)$$

As will be shown later, r_i is a fundamental quantity in the physics of the universe. The following relation can be proved correct, cf. [6],

$$G_i r_i = Gr = \frac{r_i^2 c^4}{W_e} = constant. \quad (8)$$

As a result, the present value of the radius of the observable universe is

$$r_0 = \frac{1}{G_0} \frac{r_i^2 c^4}{W_e} = 4,2056510^{26} m, \quad (9)$$

where $G_0 = 6,67408 \cdot 10^{-11} \text{ Nm}^2/\text{kg}^2$, Newton's gravitational constant. r_0 is close to the official estimate of $4,40 \cdot 10^{26} \text{ m}$.

When G_0 from eq. (9) is substituted into eq. (4) we obtain the energy of the universe

$$\begin{aligned} W_{u0} &= 2W_e \left(\frac{r_0}{r_i} \right)^2 \\ &= 1,01794810^{71} J \sim 1,13262010^{54} kg. \end{aligned} \quad (10)$$

These numbers are consistent with the official baryonic content (here 8 times those of the observable universe). Eq. (10) is valid for any arbitrary value of r , i.e. the energy is proportional to r^2 . The author has chosen the following definition

$$W_u = 4\pi b r^2, \quad (11)$$

where b is a universal energy "pressure" constant (J/m^2). From the initial event we have

$$b = \frac{2W_e}{4\pi r_i^2} = 0,4580138610^{17} J / m^2. \quad (12)$$

In summary, we write down some relations that are of importance in the rest of the study. The gravitational parameter is

$$G(r) = \frac{c^4}{2\pi b r}. \quad (13)$$

The energy density of matter (m) and radiation (γ) is

$$\rho_{m\gamma} = \frac{W_u}{V_u c^2} = \frac{3b}{8rc^2}. \quad (14)$$

In the original General Relativity text Einstein introduces what he calls the Eulerian hydrodynamic pressure p_E . The pressure is derived from basic thermodynamical principles, $dW_u = -p_E dV_u$, we have

$$p_E = -\frac{b}{4r}. \quad (15)$$

4. Expansion of the Universe

4.1. Two Kinds of Black Holes

There is a clear distinction between the *universe BH* and the *galaxy BH*. The former has a closed 4d configuration that includes everything: space, time, matter and radiation. Einstein's theory of General Relativity

is about geometry and the interpretation that curved space is the cause of the gravitational effect, nothing more. Theories about cosmos, expansion, black holes, baryonic matter are the results of our observations of the world.

The *galaxy BH* can be treated as a normal cosmological object, which so far has only shown hidden characteristics. The goal of this article is to gain a better grasp of these mysteries.

A common property of both kinds of black holes is that they are not singularities. They are dynamic objects that grow by letting streams of elementary particles enter the interior space. The *universe BH* expands, while the *galaxy BH* increases its density.

4.2. Acceleration, the Hubble Parameter

If, in the theory of General Relativity, the energy-momentum tensor $T_{\mu\nu}$ is isotropic and homogeneous, the Einstein's Field Equation

$$G_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}, \quad (16)$$

has an analytic solution. (Note that the cosmological constant has been omitted.) In the Robertson-Walker metric the solution takes the form

$$\left(\frac{\dot{a}}{a} \right)^2 = \frac{8\pi G \rho}{3} - \frac{kc^2}{a(r_{cur0})^2}, \quad (17)$$

where a is the scale factor, ρ is the average mass density (radiation included), k is the curvature factor, -1, 0 or 1, and r_{cur0} is the curvature radius at present. For the closed universe k is 1. It was established in ref. (6) that r_{cur0} equals the radius r_0 of the observable universe.

Next we seek the time derivative

$$2\dot{a}\ddot{a} = \frac{8\pi}{3} \left(Ga^2 \dot{\rho} + 2G\rho a \dot{a} + \dot{G} \rho a^2 \right) + \frac{c^2 \dot{a}}{ar_0^2}. \quad (18)$$

Using the relations $\dot{G}a\rho/G\dot{a} = -\rho$ and $\dot{\rho} = -3(\rho + p_E/c^2) \dot{a}/a$, we arrive at

$$\frac{\ddot{a}}{a} = \frac{4\pi G}{3} \left(-2\rho - \frac{3p_E}{c^2} \right) + \frac{c^2}{2(ar_0)^2}, \quad (19)$$

where the last term represents the curvature's influence on the acceleration. When G , ρ and p_E from eqs. (13-15) are substituted in eq. (19), it appears that the density and pressure terms exclude each other. The curvature is the only term that causes acceleration. We have

$$\frac{\ddot{a}}{a} = \frac{c^2}{2r^2}. \quad (20)$$

This is the acceleration of the universe expansion in 4d. In order to obtain the projection into our 3d world we must multiply r with a factor π , cf. the denominator of eq. (6), where the distance between the initial positron and electron is taken to πr . However, the factor is exactly π only at $t = 0$ and $t = \infty$, in between we need a mathematical correction factor

$$v_B = \left(\frac{1}{2\sqrt{LD_+}} \right)^2. \quad (21)$$

Here $L = \sqrt{(r/r_i) + 1/4}$, where $1/4$ is due to the increase of momentum during expansion, cf. [6], Section 3, and D_+ is the Dawson error integral function, see below. v_B is a number close to 1. We now introduce an acceleration parameter B

$$B = \frac{v_B^2}{\pi^2}. \quad (22)$$

The 3d acceleration is

$$\frac{\ddot{a}}{a} = \frac{c^2}{2r^2} B. \quad (23)$$

This is an inherent characteristic of the expanding universe. It causes a Coriolis effect everywhere and interferes with the movements of stellar objects in the galaxies. As a result, dark matter becomes completely artificial.

Simple integration leads to the time derivative of the scale factor

$$\dot{a} = \frac{c}{r_0} \sqrt{BL}. \quad (24)$$

For $r_0 = 4,20565 \cdot 10^{26}$ m, $L = 96,72$, and $B = 0,09922$ we have the Hubble parameter $\mathbf{h} = \dot{a} = \mathbf{2,2082 \cdot 10^{-18}}$ 1/s, $\mathbf{H} = \mathbf{68,14 \cdot 10^3}$ m/s/Mpc, numbers that are in good agreement with present data.

4.3. The Age of the Universe

The time function of the expansion is obtained by integration. We substitute $u = \ln(a/a_i)$, where $a_i = r_i/r = 1,2682 \cdot 10^{-42}$, into eq. (24)

$$\int a_i \frac{e^u du}{\sqrt{u}} = \int \frac{c}{r_0} \sqrt{B} dt. \quad (25)$$

The integral on the left-hand side has an error function solution

$$\int a_i \frac{e^u du}{\sqrt{u}} = -a_i i \sqrt{\pi} \cdot \operatorname{erfi}(\sqrt{u}). \quad (26)$$

The real part solution is obtained by using the Dawson integral function $D_+(\sqrt{\ln(a/a_i)})$. The time is a function of radius r according to

$$t(r) = D_+ \frac{2r}{c\sqrt{B}}. \quad (27)$$

D_+ is directly obtainable from Wolfram Alpha (Dawson(x)): $D_+ = 0,0511743$ for $a = 1$.

The age of the universe at $r = r_0$ is $\mathbf{t_0} = \mathbf{4,55 \cdot 10^{17}}$ s = $\mathbf{14,42}$ Gyr, slightly higher than the official estimate of 13,8 Gyr, discrepancy of less than 5 %.

5. The Schrödinger Equation

This section offers a bridge between quantum mechanics and gravity and is important for the understanding of the emergence of the universe.

The time-dependent Schrödinger equation is

$$\nabla^2 \psi + \frac{8\pi^2 m_e}{h^2} (E_i - U_i) \psi = 0, \quad (28)$$

where ψ is the quantum-mechanical wave function, E_i is the ground state energy, $U_i = 4\pi b r_i^2$ equals the potential energy. The spherically symmetric form of eq. (28) is

$$\frac{\partial^2 \psi}{\partial r^2} + \frac{2}{r} \frac{\partial \psi}{\partial r} + \frac{8\pi^2 m_e}{h^2} E_i \psi - \frac{32\pi^3 m_e b}{h^2} r^2 \psi = 0, \quad (29)$$

where r is the curvature radius and b the energy constant of eq. (12).

Let

$$\frac{a_1^4}{4} = \frac{h^2}{32\pi^3 m_e b}, \quad (30)$$

$$C = \frac{8\pi^2 m_e}{h^2} E_i. \quad (31)$$

The Schrödinger equation takes the form

$$\frac{\partial^2 \psi}{\partial r^2} + \frac{2}{r} \frac{\partial \psi}{\partial r} + C \psi - \frac{4}{a_1^4} r^2 \psi = 0. \quad (32)$$

This Sturm-Liouville type differential equation has the solution

$$\begin{aligned} \psi(r) = & \frac{1}{r} e^{-\left(\frac{r}{a_1}\right)^2} \left[c_1 H_n \left(\frac{r}{a_1} \right) \right] \\ & + \frac{1}{r} e^{-\left(\frac{r}{a_1}\right)^2} \left\{ c_2 |F|_{(a;b;x)} \left[\frac{1}{4} (1 - C a_1^2); \frac{1}{2}; \left(\frac{r}{a_1} \right)^2 \right] \right\}, \end{aligned} \quad (33)$$

where H_n denotes the Hermite polynomial function and $|F|_{(a;b;x)}$ denotes the Kummer confluent hypergeometric function. c_1 and c_2 are constants of integration.

The constant a_1 is in a key position

$$a_1 = \sqrt{\frac{h}{2\pi} \frac{1}{\sqrt{2\pi b m_e}}}. \quad (34)$$

By substituting b we have

$$\frac{1}{\sqrt{2\pi b m_e}} = \frac{r_i}{m_e c}. \quad (35)$$

And by inserting G_i from eq. (5) we obtain

$$a_1 = \sqrt{\frac{h G_i}{2\pi c^3}} = \ell_{Pi}. \quad (36)$$

By definition ℓ_{Pi} is the Planck length of the virgin universe. In the CBU theory the Planck length is dependent on the radius r – and time. The numerical value is $\ell_{Pi} = \mathbf{1,435164 \cdot 10^{-14}}$ m.

It can be shown that

$$\left(\frac{\ell_{Pi}}{2r_i} \right)^2 = \frac{2\pi - 1}{4\alpha_{fs}}, \quad (37)$$

where α_{fs} is the fine structure constant $1/137,036$. The result is not a coincidence, but a purely physical relation based on known physical constants. The equation emphasizes the significance of the Planck scale and the curvature radius r_i of the virgin universe. It might be seen as a proof of the connection between gravity and quantum mechanics.

Equation (37) reflects the intuitive thought expressed by, among others, Richard Feynman in the 50ies: "137 holds the answers to the Universe", [12]. Here is the key.

We obtain a general expression for the Planck length by substituting G from eq. (13) into eq. (36)

$$\ell_P(r) = \ell_{Pr} = \frac{1}{2\pi} \sqrt{\frac{hc}{br}}. \quad (38)$$

A simple check using $r_0 = 4,20565 \cdot 10^{26}$ m shows that the Planck length according to eq. (38) results in $1,616255 \cdot 10^{-35}$ m, which exactly equals the official value.

In analogy with the hydrogen atom the ground state energy E_i is postulated to be of the form

$$E_i = \frac{h^2}{8m_e \ell_{Pi}^2} = \frac{hc}{4\pi r_i}. \quad (39)$$

The general expression of the instantaneous ground state energy takes the form

$$\begin{aligned} E_{GS}(r) &= E_{GSr} = \frac{h^2}{8m_e \ell_{Pi} \ell_{Pr}} \\ &= \frac{\pi hc \ell_{Pi}}{4 \ell_{Pr} r_i} = \pi^2 \frac{\ell_{Pi}}{2r_i} \sqrt{hcb} \end{aligned} \quad (40)$$

The Planck energy W_P has an important bearing on the inflow of new matter. By definition

$$W_{Pi} = \sqrt{\frac{hc^5}{2\pi G_i}} = \frac{\ell_{Pi}}{r_i} W_e. \quad (41)$$

At the initial event a positron and an electron are exited, we deduce from eq. (41) that the particles originate from

$$2W_e = \frac{W_{Pi}}{\ell_{Pi} / 2r_i}. \quad (42)$$

The significance of $\ell_{Pi}/2r_i = 13,453499$ in the CBU theory is obvious, if W_{Pi} is considered the virtual dark energy of the virgin universe, then the real energy is obtained by dividing with the ratio $\ell_{Pi}/2r_i$.

The general expression for $W_P(r) = W_{Pr}$ is

$$W_{Pr} = \sqrt{hcb}r. \quad (43)$$

The present value $1,9560815 \cdot 10^{-9}$ J is in full compliance with the official value.

A comparison of eq. (43) with eq. (40) shows that

$$E_{GSr} = \pi^2 \frac{\ell_{Pi}}{2r_i} W_{Pr}. \quad (44)$$

6. The Mechanism for Lifting Particles from the Quantum Vacuum to the Real World

6.1. The Universe Black Hole

As a general principle there is a time window, during which particles can escape the virtual vacuum energy landscape. The pace of particle inflow is obtained from the ratio of Planck energy W_{Pr} and Planck time $t_{Pr} = \ell_{Pr}/c$. We multiply with F_r , from Appendix A, in order to obtain an integrable function of the dark energy W_{DE} , we write

$$\begin{aligned} \frac{dW_{DE}}{dt} &= F_r \frac{cW_{Pr}}{\ell_{Pr}} \\ &= 4c\sqrt{BL} \frac{\ell_{Pi}}{2r_i} 2\pi br = 8\pi brc \sqrt{BL} \frac{\ell_{Pi}}{2r_i}. \end{aligned} \quad (45)$$

Note that $c\sqrt{BL}$ is equal to dr/dt , whereby we through integration obtain

$$W_{DE} = 4\pi br^2 \frac{\ell_{Pi}}{2r_i} = W_u \frac{\ell_{Pi}}{2r_i}. \quad (46)$$

The ratio between the real energy and the virtual dark energy is

$$\frac{W_{DE}}{W_u} = \frac{\ell_{Pi}}{2r_i} = \sqrt{\frac{2\pi-1}{4\alpha_{fs}}}. \quad (47)$$

The result is ground-breaking, it mathematically connects the real energy of the universe with its origin. A check with present data: $\Omega_b = 0,05$, tells us that $\Omega_b \cdot (\ell_{Pi}/2r_i) = 0,67 \approx \Omega_\Lambda$. There are still uncertainties in the observed relative density data, Ω_b is too small, as is shown in Table 1, it must include all forms of energy, even neutrinos.

Because the electrons and positrons are picked from the instantaneous value of the Planck energy $W_{Pr}(t)$, W_{DE} should be regarded as virtual.

6.2. The Galaxy Black Hole

The galaxy black holes originate from a transition that is thought to have happened when the CMB radiation was released. During the primordial state of the expansion electrons and positrons form a plasma wherein there occurs annihilations. At a certain point half the energy is still in particles while the other half is confined to pairwise entangled photons. These photons are not influencing gravity, whereby the Schwarzschild condition is broken, and the universe undergoes a transition. Matter is trapped into a multitude of "small" black holes. Based on the CMB scale factor, $a_c = 3,523 \cdot 10^{-5}$ (Appendix B), we can estimate the total energy of the black holes to be: $W_{Bctot} = 0,5 \cdot 4\pi br^2 a_c^2 = 6,3176 \cdot 10^{61}$ J.

Several comprehensive analyses indicate that the radius, R_B , of an individual black hole does not change with time. The radius is obtained from

$$R_B = \frac{M_B G}{c^2} \quad (48)$$

where M_B is the mass of the black hole and G is the gravitation parameter of the universe at a given time. The equation is based on the photon radius, i.e. half the Schwarzschild radius. With R_B constant and $G \propto 1/a$, M_B is directly proportional to a . Presently the total energy of all black holes will then be

$$\begin{aligned} W_{B0tot} &= W_{Bctot} a_c^{-1} \\ &= 1,79310^{66} J \propto M_{B0tot} = 2,0010^{49} kg. \end{aligned}$$

There are different estimates of the number of galaxies in the universe, a number that has changed due to mergers. According to one estimate the number of galaxies in the observable universe is $2 \cdot 10^{11}$ which means a total of $N_G = 1,6 \cdot 10^{12}$. This leads us to an average BH mass of $M_B = 1,25 \cdot 10^{37}$ kg or $6 \cdot 10^6$ solar masses. The black hole of the Milky Way Sagittarius A* is estimated to have a mass of $8,3 \cdot 10^{36}$ kg.

By substituting G from eq. (13) into eq. (48) we obtain the equation of the black hole mass

$$M_B = \frac{2\pi b R_B r}{c^2}. \quad (49)$$

The equation reminds of the energy of the universe, but instead of $2r^2$ we have $R_B \cdot r$.

Inside the black hole there is a local gravitational parameter G_B . By utilizing eq. (8) we may write

$$G_B = \frac{r_i^2 c^4}{R_B W_e} = \frac{c^4}{2\pi b R_B}. \quad (50)$$

The relation resembles the equation for G , eq. (13), but R_B being constant means that even G_B is constant for the specific BH.

6.3. Why no Singularity?

In the case of the *universe BH* it was shown that the density and equivalent Eulerian pressure (definition by Einstein in his original paper on GR) sum up to zero, there is no force driving matter into a singularity. The curvature of the space governs the electron-positron inflow and thereby regulates the pace of expansion. In a *galaxy BH* we can equally define the balance equation of expansion and contraction.

The pressure of expansion is obtained from the 1st Law of Thermodynamics

$$\frac{dW}{dt} + p \frac{dV}{dt} + V \frac{dp}{dt} = 0. \quad (51)$$

The volume V is constant along with R_B . We are left with the equation

$$\frac{dW}{dt} = -V \frac{dp}{dt}. \quad (52)$$

The expansion pressure is

$$p_{Bexp} = -\frac{W_B}{V_B} = -\frac{3br}{2R_B^2}. \quad (53)$$

The acceleration directed outwards is

$$g_{Bexp} = \frac{4\pi G_B p_{Bexp}}{3c^2} = -\frac{rc^2}{R_B^2}. \quad (54a)$$

Alternatively, we obtain the same result by considering $g = -\nabla\phi$, where $\phi = -G_B M_B / R_B$.

For the symmetric spherical case we have

$$g_{Bexp} = \frac{\partial}{\partial R_B} \left(\frac{rc^2}{R_B} \right) = -\frac{rc^2}{R_B^2}. \quad (54b)$$

QED! Here r is considered to be constant.

The acceleration inwards due to gravitation is obtained from the familiar equation

$$g_{Bcontr} = \frac{G_B M_B}{R_B^2} = \frac{rc^2}{R_B^2}. \quad (55)$$

Obviously,

$$g_{Bexp} + g_{Bcontr} = 0. \quad (56)$$

7. The Ground State and the Inflow of Baryonic Matter

A further analysis of the ground state energy at the initial event, E_{GSi} , leads to an interesting coincidence:

$$\begin{aligned} E_{GSi} &= \pi^2 \left(\frac{\ell p_i}{2r_i} \right) W_{Pr} \\ &= \pi^2 \left(\frac{\ell p_i}{2r_i} \right)^2 (2W_e) = \pi^2 \frac{2\pi-1}{\alpha_{fs}} (2W_e), \end{aligned} \quad (57)$$

where W_e is the rest energy of the electron. It appears that the constant factor before $2W_e$ is very close to the proton-electron mass ratio 1836,153. We write

$$\frac{m_p}{m_e} = \frac{1}{v_{Bi}^2} \pi^2 \frac{2\pi-1}{\alpha_{fs}}, \quad (58)$$

where $v_{Bi} = 0,9863493$. It is our conjecture, that v_{Bi} is the initial correction factor as estimated from eq. (21). We write

$$E_{GSi} = v_{Bi}^2 (2W_p), \quad (59)$$

where W_p is the rest energy of the proton. v_{Bi} represents a short delay between the entry of the first electron-positron pair at $t = 0$ and the entry of the proton-antiproton pair.

Embryo of a theory: The black hole has two boundary spheres, the inner one or the photon sphere, $r_B = 0,5 \cdot r_S$ (r_S = Schwarzschild radius), and the outer one or the black hole event horizon at r_S . In between there is a forbidden energy gap. The number of pairs depends on the geometry.

1) The closed *universe BH* follows the rule

$$W_{us} = E_{GSr} = 2v_{Bi}^2 W_p \sqrt{\frac{r}{r_i}}. \quad (60)$$

We use W_{us} for the energy state at the Schwarzschild boundary. The square root, cf. eqs. (10), (43) and (44), indicates the number of proton-antiproton pairs injected.

The present value $W_{uS} = 2,60 \cdot 10^{11}$ J is an insignificant amount compared the W_u .

2) In the *galaxy BH* case the number of injected pairs, N_{pair} , is equal on the inside and on the outside, $\sqrt{(R_B/R_B)} = 1$.

We now postulate that all the matter and radiation, mainly stellar mass, in the galaxy originate from the central black hole. This leads to a clear-cut relation between the stellar (galaxy) mass, M_G , and the BH mass, M_B . We have

$$\frac{M_G}{M_B} = \frac{2v_{Bi}^2 m_p N_{pair}}{2m_e N_{pair}} = v_{Bi}^2 \frac{m_p}{m_e} = 1786,4. \quad (61)$$

This is a significant result. Some bold presumptions lead to a result that has a strong anchorage in present observations. The average example of Section 6.2, $M_B = 1,25 \cdot 10^{37}$ kg, suggests a galaxy stellar content of $2,23 \cdot 10^{40}$ kg, which is a typical value.

During the last decade several papers have been published, wherein the mass ratio is discussed and different theories about the cause has been presented, cf. [13,14,15]. Typically, it is presumed that stellar matter feeds the black holes, not vice versa as the present theory (CBU) asserts.

An indication, that the CBU result is the most reasonable one, is shown in Figure 2. The line $M_B = [v_{Bi}^2 (m_p/m_e)]^{-1} \cdot M_G$ is shown in a chart created by Sandra Faber, [16]. There is a perfect fit with the ‘‘Small dense’’ galaxies. The line shows there is a linear correlation, which for the present theory means that M_B grows linearly and the assumption of R_B being constant is correct.

I leave the discussion of the difference between the ‘‘Small dense’’ and ‘‘Large diffuse’’ curves to fellow researchers. During the history of galaxies things happen, galaxies merge, one galaxy steals matter from another, etc. Available data include variations in accuracy. The CBU theory also contains uncertainties, such as the precise timing of the CMB, and the transition process itself, what is the distribution of energy among galaxy seed black holes?

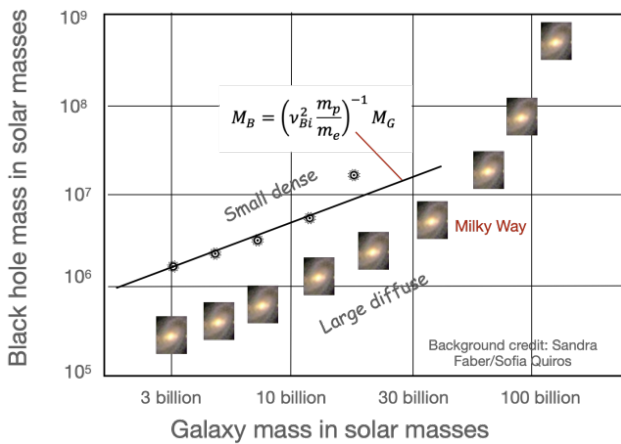


Figure 2. A broadly published chart showing the results of the relation $M_B = f(M_G)$ for numerous observed galaxies, [16]

The energy gap between the inner photon sphere and the Schwarzschild event horizon must be as large as the negative potential energy. The proof is simple. The potential energy at $r_s = 2R_B$ is

$$W_{pot}(r_s) = M_G c^2 = \frac{2GM_G M_B}{2R_B}. \quad (62)$$

Because we observe the system from the outside, G is obtained from eq. (13). When G is substituted into eq. (62) and M_B from eq. (49), we end up with a proof of the required condition. As M_B increases, with time, G will decrease, R_B remains constant.

The same evidence applies to the *universe BH*, just replace R_B with $2r$ and M_B with M_u . However, $M \propto a^2$, $r \propto a$ and $G \propto 1/a$, the condition holds even if the universe expands. Here is a difference compared to the proposals by Dirac and Brans & Dicke, they did not recognize the balance requirement between positive and negative energy.

8. The Total Energy, Comparison of Models

In the original CBU model it was assumed, that the total energy was only proportional to the curvature radius r squared. However, the new findings require the addition of a term considering the energy generated by the *galaxy BHs*. Notice, that this is not free energy, the negative counterpart is the gravitational potential energy provided by the increasing density of the BH. The potential acts over the gap between R_H (event horizon, equal to the Schwarzschild radius) and R_B .

The energy due to the electron-positron inflow is

$$W_{ue^+e^-} = 4\pi b r^2. \quad (63)$$

The total energy of the galaxies and the black holes is

$$W_{GB} = W_{Gu} + W_{Bu} = 2\pi b r^2 a_c \left(v_{Bi}^2 \frac{m_p}{m_e} + 1 \right), \quad (64)$$

where W_{Gu} and W_{Bu} are the overall energies of the galaxies and the black holes respectively.

The earlier estimate of the total energy (matter and radiation) was $W_{u0} = 1,018 \cdot 10^{71}$ J. The new value will be $W_{u0tot} = 1,050 \cdot 10^{71}$ J. The increase due to the galaxies is 3,147 %.

The critical density is

$$\rho_{cr} = \frac{3h_0^2}{8\pi G_0} = 8,72 \cdot 10^{-27} \frac{kg}{m^3}, \quad (65)$$

where $h_0 = 2,208 \cdot 10^{-18}$ 1/s and $G_0 = 6,67408 \cdot 10^{-11}$ m³/kg/s². The total critical energy is $W_{cr} = 1,9536 \cdot 10^{72}$ J. As a result the density parameters are $\Omega_{by} = 0,05375$ (matter and radiation) and $\Omega_{\Lambda} = 0,723$ (virtual accumulated dark energy).

Table 1 shows a comparison between some key data calculated according to the competing theories CBU and Λ CDM (standard model).

The numbers are in good agreement, especially considering the different approaches. The main discrepancies relate to the interpretation of the energy content. In the standard model dark energy and dark matter are considered real, while in the CBU dark energy is a virtual ingredient, the vacuum energy from which the universe, in accordance with the uncertainty principle,

picks up particles that accumulate into real energy. However, the virtual vacuum energy does not lead to an accumulation. Further, the CBU does not require dark matter to explain galaxy dynamics, the Coriolis effect takes care of that part.

Table 1. CBU versus Λ CDM

| Quantity | CBU | Λ CDM [17] | Diff. % |
|---|----------|-----------------------|---------|
| Radius of the obs. universe, 10^{26} m | 4,206 | 4,396 | +4,5 |
| Age of the universe, 10^9 y | 14,45 | 13,797 | -4,7 |
| Hubble parameter, 10^3 m/s/Mpc | 68,1 | 67,4 | -1,0 |
| Critical density, 10^{27} kg/m ³ | 8,72 | 8,57 | -1,8 |
| Baryonic energy + rad. density parameter, Ω_{by} | 0,05375 | 0,0498 | -5,9 |
| Dark energy density parameter, Ω_Λ | 0,723 | 0,686 | -5,4 |
| Total real energy, 10^{71} J (baryonic + radiation) | 1,050 | 1,079 | +2,7 |
| CBU: Free space, 10^{71} J | 1,018 | | |
| CBU: Black holes, 10^{71} J | 0,000018 | | |
| CBU: Galaxies, 10^{71} J | 0,0320 | | |

9. Conclusion

It has been shown that the Planck energy divided by the Planck time, further enhanced with a gravitational uncertainty factor, provides the time derivative of the virtual dark energy. Integration with respect to time and division with a universal constant, $\sqrt{((2\pi-1)/a_{fs})}$, a_{fs} being the fine structure constant, gives as result the real energy content of the expanding universe.

As an important result it was shown that the ground state energy, as predicted by the Schrödinger equation, is a multiple of baryons. At the initial event the ratio of baryons to leptons almost equals the proton-electron mass ratio, which only requires a correction factor of 0,973. This points to the conclusion that the black holes of the galaxies generate protons and antiprotons outside the event horizon and simultaneously electrons and positrons inside the black hole, the number ratio being 1. We now have a conjecture for the ratio between the galaxy stellar mass and the black hole mass, $0,973 \cdot (m_p/m_e) = 1786$. There is a good statistical average supported by observed data.

The fact that the initial event provides a constant, which is very close to the m_p/m_e ratio, suggests a strong connection between the gravitational universe and quantum mechanics. Why is the mass ratio of the most stable and most important particles in the universe determined in the very process of creation?

For the time being we emphasize that the black hole theory is indicative for further research. The accretion disk hints that black holes are of the rotating Kerr type. The violent activity in the vicinity of the event horizon of central black holes supports the idea that nuclear processes are ongoing, neutrons and hydrogen atoms are evolving, the event horizon radiates x-rays.

Appendix A: Generalized Uncertainty

The analysis is based on an open access article by the present author, [6].

A generalized form of the Heisenberg uncertainty principle has an important impact on the production of new e^+e^- pairs. Because of the dynamic change of the momentum the uncertainty window is much wider than that provided by the classical Heisenberg formulation, cf. Adler [18]. We divide Δx into a Heisenberg component $\Delta x_H = h/(4\pi\Delta p)$ and a gravity component

$$\Delta x_g = \frac{h}{4\pi\Delta p_g}. \quad (A1)$$

The momentum uncertainty is

$$\Delta p = \frac{dp}{dr} \ell_{Pr}. \quad (A2)$$

We have

$$\frac{dp}{dr} = \frac{8\pi br}{c} \sqrt{BL} \left(1 + \frac{1}{4L}\right), \quad (A3)$$

where the term containing $1/4L$ is due to the fact that L is a $\ln(r)$ function.

Assuming that the location uncertainty is $\Delta x = \ell_{Pr}/2$ we have

$$\Delta p \Delta x_H \leq \frac{1}{2} \frac{dp}{dr} \ell_{Pr}^2 = \frac{h}{4\pi} f_r, \quad (A4)$$

where

$$f_r = 4\sqrt{BL} \left(1 + \frac{1}{4L}\right). \quad (A5)$$

Ronald J. Adler has derived an expression for the gravity component, [18],

$$\Delta x_g = 2\pi \frac{\Delta p \ell_{Pr}^2}{h} = \frac{2h}{4\pi\Delta p} \left(\frac{2\pi\ell_{Pr}\Delta p}{h}\right)^2. \quad (A6)$$

After some algebraic manipulation we arrive at the final uncertainty equation

$$\Delta p \Delta x = \Delta p (\Delta x_H + \Delta x_g) \leq \frac{h}{4\pi} (f_r + f_r^2) = \frac{h}{4\pi} F_r, \quad (A7)$$

where $F_r = f_r(1 + f_r)$ is the overall uncertainty factor. When f_r is substituted into F_r , we obtain a proximity value to the real uncertainty factor: $F_{rU} = 4\sqrt{BL} \cdot (\ell_{Pr}/2r_i)$, which applies to the *universe BH*. A similar analysis leads to $F_{rB} = \sqrt{BL} \cdot (\ell_{Pr}/2r_i)$ for the *galaxy BH*.

Appendix B. Determination of the Scale Factor at CMB

The analysis is based on an open access article by the present author, [19].

Influence of Gravitation on the Redshift

The gravitational parameter G is extremely large in the initial phase, $G_i \approx 5 \cdot 10^{31}$ m³/kg/s². The parameter decreases successively with the expansion. The photons of the Cosmic Microwave Background (CMB) are propagating faster than the expansion and must climb a gravitational

upward slope. We write the energy equation for electromagnetic radiation propagating in a gravitational gradient

$$hdf + g \frac{hf}{c^2} dr = 0, \quad (B1)$$

where f is the frequency, g the gravitational acceleration along r . We obtain g from

$$g = \frac{GM}{r^2} = \frac{2c^2}{r}. \quad (B2)$$

Here we made use of $M = 4\pi br^2/c^2$ and $G=c^4/2\pi br$, cf. eq. (4). Having that $f = c/l$, $df = -cdl/l^2$ and $r = r_0 a$, where a is the scale factor, we write

$$\int \frac{d\lambda}{\lambda} = 2 \int \frac{da}{a}. \quad (B3)$$

Integration implies that l is proportional to a^2 . We deduce that

$$\frac{\lambda_0 - \lambda_s}{\lambda_s} = \left(\frac{1-a}{a} \right)^2 = z_g. \quad (B4)$$

Here z_g is the gravitational redshift, λ_s and λ_0 are the wavelengths at the source and at the observer respectively.

As known the cosmological redshift is

$$z_{cr} = \frac{1}{a} - 1. \quad (B5)$$

The combined redshift is $z = z_g + z_{cr}$. We have

$$\frac{\lambda_0}{\lambda_s} = \frac{f_s}{f_0} = z + 1 = \frac{1-a+a^2}{a^2}. \quad (B6)$$

Let a_c stand for the scale factor at the CMB event. For very small values of the scale factor the frequency of CMB photons decrease approximately according to

$$f_o \approx a_c^2 f_c. \quad (B7)$$

The Scale Factor at the CMB Event

The energy density of the black body radiation we obtain from the classical Stefani-Boltzmann equation

$$w_{BB} = \frac{8\pi^5 k_B^4}{15c^3 h^3} T^4 = \alpha_B T^4. \quad (B8)$$

Here $a_B = 4s_{SB}/c = 7,565723 \cdot 10^{-16} \text{ J/K}^4 \text{ m}^3$ is the density constant, s_{SB} is the Stefani-Boltzmann constant, and k_B the Boltzmann constant.

The number density of the photons is obtained from, cf. Wikipedia: Photon Gas,

$$n_{ph} = 16\pi\zeta(3) \left(\frac{k_B T}{ch} \right)^3, \quad (B9)$$

where $z(3) = 1,202056$ is the Riemann zeta-function. By dividing eq. (18) with eq. (19) we obtain an expression for the photon energy

$$W_{ph} = \frac{\alpha_B T}{16\pi\zeta(3)} \left(\frac{ch}{k_B} \right)^3. \quad (B10)$$

If we assume that the photon energy at the CMB event equals one of the two photons caused by the annihilation, we have $W_{phc} = W_e$. The present time photon energy is then

$$W_{ph0} = a_c^2 W_e = \frac{\alpha_B T_0}{16\pi\zeta(3)} \left(\frac{ch}{k_B} \right)^3. \quad (B11)$$

Accordingly, for $T_0 = 2,72548 \text{ K}$ we have

$$a_{CMB} = a_c = \sqrt{\frac{\alpha_B T_0}{16\pi\zeta(3)} \left(\frac{ch}{k_B} \right)^3 \frac{1}{W_e}} = 3,52310^{-5}. \quad (B12)$$

Due to the square root the figure is much smaller than usually suggested ($10^{-7} \dots 10^{-9}$).

The present photon energy is $W_{ph0} = 1,0164 \cdot 10^{-22} \text{ J}$, eq. (B11), and the corresponding frequency $f_0 = W_{ph0}/h = 153,4 \text{ GHz}$, slightly below the Planck black body spectrum optimum frequency of $f_{imax} = 160,23 \text{ GHz}$.

Competing interests

The author declares that there are no competing interests.

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