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QUANTIFYING THE UNSEEN: CALCULATING DARK ENERGY AND DARK MATTER

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Abstract
The pursuit of a comprehensive understanding of the universe has led to the exploration of intriguing phenomena, such as dark energy, which remains an enigmatic force responsible for the accelerated expansion of the cosmos. In this work, we derive a novel formula for calculating dark energy, unveiling a fresh perspective on this elusive cosmic component. Our approach hinges on the fundamental concepts of the Planck time (tp) and the oscillatory nature of dark energy, which we establish as conforming to the Planck/Einstein formula. Through this derivation, we demonstrate how the quotient h/tp encapsulates the essential energy information required for the calculation of dark energy. Notably, this derivation is founded on the relatively simple assumptions that Planck time is an oscillation period (τ), and dark energy adheres to the Planck/Einstein formula.

1. Derivation of a formula for calculating dark energy

The quotient h/t_p represent an energy that leads to the derivation of a formula for calculating dark energy.
This requires only the assumptions that the PLANCK time t_p is an oscillation period τ and dark energy satisfies the PLANCK/EINSTEIN formula

$$E = h\,\nu \tag{1.1}$$

Oscillations are fundamental oscillations of the cosmic space [1, pg.15]. THOMAS GÖRNITZ says: „Structural quanta emerge from a quantum-theoretical description of „oscillation states“ of a system around its ground state. They produce many effects. The AQIs of protyposis are also structural quanta and not particles. One can interpret them as the „fundamental oscillations of the cosmic space“.

For dark energy E_d this then leads to:

$pE_d = h / t_p = 1.229\times10^{10}$ J in PLANCK time

$1E_d = 2.28\times10^{53}$ J in 1 s

$\underline{E_d = 0.994\times10^{71}\text{ J}}$ in 13.8 billion years for the age of the universe $t_u = 4.358\times10^{17}$ s

The following formula for calculating the dark energy in the universe is then derived from these calculation steps:

[1] Schulstrasse 57, D-31812 Bad Pyrmont, Germany

$$E_d = h\, t_u / t_p^2 \qquad (1.2)$$

This simple three-sentence operation was found by THOMAS GÖRNITZ [1] in a more in-depht manner, resulting in very well-matched numerical values. A connection to the empirical is thus achieved. Data shows us the nature of things as well as theories.

2. Verification of the result

In order to show the good concordance of the value calculated according to the formula of dark energy with the value calculated from the existing data, the data from the MAX PLANCK Institute for Radio Astronomy are used as a basis. Accordingly, the mass/energy of the universe is composed as follows:

70% dark energy
25% dark matter
4-5% visible baryonic matter
0.3% neutrinos

In *Grenzgebiete der Wissenschaft* [2, pg. 218] the enegy equivalent for the visible matter in the universe is deducted as follows:

For the theoretical calculation, the universe is considered to be a single black hole, just as one imagines, according to a popular theory, the final stage of the universe. THOMAS GORNITZ has also expressed the idea of the cosmos as a single black hole [1, pg.30 at the end of 7.2]. He writes: “From this point of view, it makes perfect sense to think about whether our cosmos can be interpreted under certain aspects as the interior of a gigantic black hole.” Then, with the black hole entropy (BEKENSTEIN-HAWKING entropy) SH = kc^3 AH / (4ħG) and HAWKING temperature TH = $\hbar c^3 / (8\pi kGM)$, one obtains the formula THSHM / AH = $(2/G)^2 (c/2)^6 / (2\pi)$. If one sets THSH = QH = E = Mc^2 and for the area of the black hole event horizon $A_H = 4\pi R^2$, which measures the information potentially contained in it, one obtains for the visible mass M of the universe $M^2c^2 / (4\pi R^2) = 4c^6 / (2^6\, G^2\, 2\pi)$ and $M = 8^{1/2}\, c^2\, R/(2^3\, G)$.With the HUBBLE relation R = c/H0 yields $M = 8^{1/2}\, c^3 / (2^3\, GH_0)$. $M = E/c^2$ is given by

$$E_M = c^5 / (8^{1/2}\, G\, H_0) = 5.61\times10^{69}\ \text{J} \qquad (2.1)$$

A numerical value that STEPHEN HAWKING calculated for the entire current visible mass energy equivalent of the universe [3, pg.1355]. This theoretically calculated value, which corresponds to 10^{80} proton masses, and which makes up the major part of the cosmic energy of the matter, can be compared with the value calculated from the volume and density of the universe [4, pg.850]. This value agrees well with the theoretically calculated value.

Based on the available data of the MAX PLANCK Institute for Radio Astronomy and with H0 = $2.285\times10^{-18}\ s^{-1}$ this results in the dark energy: 5.61×10^{69} J ・ 70 / 4 = $\underline{0.982\times10^{71}\ \text{J}}$.

H0 = 70.5 km s^{-1} Mpc^{-1} according to WMAP5

Whilst the matching of numeric values cannot replace a theory, a good theory must nevertheless be measured according to the concordance of numerical values. In this respect, the calculation supports the assumptions (theory) made for the formula (1.2).

A further possibility of validation is given through the application of the equation (4) from *Grenzgebiete der Wissenschaft* [2, pg. 226]. Accordingly, the energy is equivalent to the information flow H/t with H = SHANNON information entropy and t = time:

$$E = h \cdot \ln 2 \cdot H/t \qquad (2.2)$$

HARTMUT ISING [5] and LIENHARD PAGEL [6] also developed a corresponding formula.

The formula (2.2) should be deducted exactly here from the DE BROGLIE formula [7]:

The DE BROGLIE formula is: A/h = S/k. This results in A = (h/k) S → AT = (h/k) ST = (h/k) Q. E = hν = kT → T = hν / k. A hν / k = (h/k) Q → A ν = Q → A/τ = Q → A = Q τ → Q τ = (h/k) S. S = k · ln2 · H is given by Q = h · ln2 · H / τ .

If one then sets Δt = aτ (a = dimensionless factor), then Q = h · ln2 · a · H / (aτ) = h · ln2 · a · H / Δt → Q/a = h · ln2 · H / Δt . Q/a is Qt , then Qt = h · ln2 · H / Δt . With Qt = Et one obtains the formula (2.2).

It is identical to ISING's or PAGEL's formula except for the factor ln2. Thus, dark energy can also be understood as information flow.

The cosmic information HK is given in THOMAS GORNITZ [8] as approx. 10^{122} bit for tu = 15 billion years. From this, formula (3.2) calculates the cosmic information HK = 0.943×10^{122} bit for tu = 13.8 billion years. HK = 0.943×10^{122} bit for the cosmic information and tu = 4.358×10^{17} s yields <u>Ed =0.994×10^{71} J</u> for dark energy. So here too, very good concordance is evident.

3. Derived formulas

Using the equations (1.2) and (2.1) leads to the ratio of the energy equivalent of dark energy and visible matter

$$Ed / EM = 8^{1/2}\, G\, h / (c^5\, t_p^2) = 17.75 \qquad (3.1)$$

For the area of astrophysics, it might be relevant to theoretically calculate this relationship.

The following relationship for cosmic information HK can be derived from the formulas (1.2) and (2.2)

$$\ln2 \cdot Hk = (tu / tp)^2 \qquad (3.2)$$

This formula (3.2) was also derived by THOMAS GORNITZ in a comparable form [1, pg. 30].

The maximum possible information content Hmax , which can encode the surface of a spherical universe and which corresponds to this surface in PLANCK units, is given by Au = $4\pi R^2 = 4\pi(R/l_p)^2$. (see [9]).

With the HUBBLE relation $R = c/H_0$ and $H_0 = 1/ t_u$, $A_u = 4\pi\, (c\, t_u/l_p)^2$. With $l_p = (\hbar G/c^3)^{1/2}$ you get

$$H_{max} = 4\pi\, c^5\, t_u^2 / (\hbar G) \rightarrow H_{max} \sim t_u^2 \sim A_u \qquad (3.3)$$

$$H_{max} = 8.21\times10^{122} \text{ bit} \approx 10^{123} \text{ bit}$$

This value is in good agreement with the one identified by R. PENROSE [10]. *For comparison*, the BEKENSTEIN-HAWKING entropy is cited: $S_H = kc^3\, AH/(4\hbar G)$; with SH = k · ln2 · HH follows

$$\ln2 \cdot H_H = c^3\, A_H / (4\hbar G) \rightarrow H_H \sim A_H \qquad (3.4)$$

4. Calculation of dark matter

According to THOMAS GORNITZ, the number of AQIs (abstract quantum information) in the cosmos is N = $t_{cosmos}^2 / 2 = (tu/tp)^2 /2 = 0.32\times10^{122}$ [1, pg. 30]. This value corresponds to the value of dark matter in Table 1, where HDM = 0.33×10^{122} is given. That`s a remarkable match!

With formula (3.2) it follows:

$$HK/N = 2/\ln2 \approx 2.89 \qquad (4.1)$$

By comparing in Table 1 the informational equivalents of the dark energy HDE = HK and the total mass energy of the universe Hu , one obtains the relation

$$HDE = \ln2 \cdot Hu \qquad (4.2)$$

and Ed = $(\ln2)^2$ · h · Hu / tu . ln2 · HDE = $(tu / tp)^2 \sim Ak$

The formulas (3.2), (4.1) and (4.9) lead to

$$HBH = zBH \cdot nBH = (tu/tp)^2 /4 \qquad (4.3)$$

By combining the different informational equivalents of the energies in Table 1, a number of formulas of the ratios of the informational equivalents can be derived. Here are examples:

$$\text{Hmax} / \text{HDE} = 4\pi\, c^5\, t_p^2 / (\ln 2 \cdot \hbar G) \qquad (4.4)$$

$$\text{Hmax} / \text{HM} = 8^{3/2} \cdot \pi^2 \cdot \ln 2 \qquad (4.5)$$

The formulas (3.2) and (4.3) lead to

$$\text{HBH} = \text{HDE} \cdot \ln 2/4 \qquad (4.6)$$

$\text{HDE} / \ln 2 \sim \text{Ak} \sim (\text{tu} / t_p)^2$

Formula (4.2) results in

$$4\text{HBH} = \text{HDE}^2 / H_u \qquad (4.7)$$

And

$$H_{BH} = [(\ln 2)^2 / 4]\, H_u \qquad (4.8)$$

According to THOMAS GORNITZ, the informational equivalent of the total black holes in the universe Is

$$\text{HBH} = \text{zBH} \cdot \text{nBH} = N/2 \qquad (4.9)$$

[1, pg.28, formula (7.3)]

The number of AQIs that make up all black holes in the universe is therefore $N/2 = 0.3268\times10^{122}/2 = 0.1634\times10^{122}$. The entropy for black holes as objects in the cosmos is always smaller than the number of AQIs that form the black hole (THOMAS GORNITZ).

5. Preparation of the balance sheet

If you enter the values found in a table, you get the following picture:

Table 1: Mass energy and information balance of the universe

	symbol	%	information 10^{122} [bit]	energy 10^{71} [J]	mass 10^{53} [kg]	[J/bit]
Dark energy	$H_K = H_{DE}$	70	0.943	0.994		
Dark matter	$H_{DM} = N$	25	0.337	0.355	3.9	
Visible baryonic matter	H_M	4-5	0.054	0.056	0.625	10^{-51}
Neutrinos	H_{Neu}	0.3	0.004	0.0043		
Σ	H_u	100	1.338	1.4093		
	H_{BH}		0.1634 (contained in H_u)			
	H_{max}		8.21			
	M_{KG}				4.5 [1)]	

1) TH. GÖRNITZ [1, pg. 31] specifies $M_{KG} = 5.5\times10^{53}$ kg for the "cosmic total mass", which means a useful match.

6. Compilation of the formulas

There are three formulas in literature for the equivalence of information flow and energy. They are listed in Table 2.

Table 2: Compilation of the most important formulas

Author	formula	determined	deducted further formulas
ISING, H. and PAGEL, L.	$_{I}E = h\ H/t_u$	H_u	$E_d = h\ t_u/t_p^2$
JÖGE, F.	$_{J}E = h \cdot \ln 2 \cdot H/t_u$	H_{DE}	$\ln 2 \cdot H_{DE} = (t_u/t_p)^2$
SEDLACEK, KL. -D. GÖRNITZ, TH.	$_{G}E = (\ln 2/12\pi^2)\ h\ H/t_u$ 2)	H_{Neu}	$H_{DE} = (2 / \ln 2)\ N$ and $H_{DM}^2 = (H_{BH} \cdot H_u) / 2$ [11, pg. 40]
	$E_M = c^5 /(8^{1/2}\ GH_0)$	H_M	$H_{DE} = \ln 2\ H_u$
	$H_{DM} = (t_u/t_p)^2 /2 = H_u /4$	$H_{DM} = N$	$H_{max}/H_M \approx 8^{3/2}\ \pi^2\ \ln 2$
	$H_{max} = 4\pi\ c^5\ t_u^2/(\hbar G)$	H_{max}	$H_{BH} = (\ln 2/4)\ H_{DE}$
	$H_{BH} = (t_u/t_p)^2 /4$	H_{BH}	$H_{BH} = H_u / 8 = [(\ln 2)^2/4]\ Hu$
			$H_{BH} = N/2 = H_{DM} /2$

2) The difference between the calculations according to this formula and formula (2.2) lies in the factor $12\pi^2 = 118.8435$. It comes about due to the fact that during the expansion of the cosmos – especially during the period of inflation (see Standard Model of Cosmology) – the volume work pdV has to be considered (see the first law of thermodynamics: $dU + pdV = 0$) [1, pg. 22].

7. Conclusions

PLANCK time can be understood as the oscillation period τ. Oscillations are fundamental oscillations of the cosmic space [1, pg. 15]. The dark energy satisfies the PLANCK/EINSTEIN formula $E = h\ \nu$. Dark energy can be interpreted as information flow.

According to formula (3.2), the cosmic information multiplied by ln2 is nothing more than the age of the universe in PLANCK time units squared. The approximately fivefold amount of the currently known total information content of the universe would still have space on the surface of a spherical universe.

Dark matter corresponds to the number of AQIs in the cosmos. The informational equivalents of dark matter and the total mass energy of the cosmos are in a ratio 1/4. Dark energy and dark matter are in a ratio 2/ln2. The ratio of dark energy to the total mass energy of the cosmos is ln2.

According to the formula (4.5) the ratio H_{max} / H_M is equal to $8^{3/2} \cdot \pi^2 \cdot \ln 2$. The informational equivalent of the black holes in the cosmos is equal to HDM / 2 = Hu /8 = $[(\ln 2)^2/4]$ Hu. Half of the hypothetical particles of dark matter are distributed over the black holes in the universe and can be made accessible after the experimental production of small black holes in a particle accelerator.

These statements can serve only as the beginnings of a theory on dark energy and give cause for further research.

Definition of symbols used in formulas

A = effect, action

AH = area of the black hole event horizon measures the information potentially contained in it

Au = surface of the spherical universe, corresponding to Hu

Ak = surface of the spherical universe, corresponding to Hk

AQI = abstract quantum information (protyposis)

R = cosmic radius c = speed of light ν = frequency

E = energy

G = constant of gravitation

H0 = HUBBLE constant

H = SHANNON information entropy

HBH = informational equivalent of the total mass energy of the number of black holes in the cosmos

HDE = informational equivalent of dark energy

HDM = informational equivalent of dark matter

HK = cosmic information, HK = HDE

HNeu = informational equivalent of neutrinos

Hu = informational equivalent of the total mass energy of the universe

h = PLANCK quantum of action, ħ = h/(2π)

k = BOLTZMANN constant

M = mass

MDM = mass of dark matter

MKG = cosmic total mass

MM = mass of visible baryonic matter N = number of AQIs in the cosmos nBH = number of AQIs for a black hole

p = pressure Q = thermal energy

S = thermodynamic entropy

SH = BEKENSTEIN HAWKING entropy

T = absolute temperature τ = period of oscillation t = time

tu = age of the universe tp = PLANCK time lp = PLANCK length

U = internal energy V = volume

z_{BH} = nummer of black holes in the cosmos (THOMAS GÖRNITZ [1])

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