Dark Energy and Dark Matter

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Abstract
The rudiments of a theory of dark energy. The theoretical result is confronted with the numerical value calculated from the available data. Excellent matching of numerical values resulting in three independent paths makes the approach plausible. The work at hand is analogous to KEPLER`s laws of planetary orbits. Only ISAAC NEWTON put KEPLER`s laws on a theoretical basis, which is provided here by THOMAS GÖRNITZ [1]. The empirical BALMER formula was also theoretically justified by Niels Bohr.

Summary
The derivation of a formula for calculating dark energy is described. The result is tested on the basis of the available data from the MAX PLANCK Institute for Radio Astronomy. Further formulas are deducted. The dark matter of the cosmos is calculated. A balance sheet is drawn up. Conclusions are drawn.

1. Derivation of a formula for calculating dark energy

Dark energy can be calculated if one makes the assumptions that PLANCK time t_p is an oscillation period τ and dark energy satisfies the PLANCK/EINSTEIN formula

$$E = h\,\nu \qquad (1.1)$$

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
$E_d = \underline{0.994\times10^{71}\text{ J}}$ 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:

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

This simple three-sentence operation was founded by THOMAS GÖRNITZ [1] in a more in-depth 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 energy 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

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imagines, according to a popular theory, the final stage of the universe. THOMAS GÖRNITZ 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) $S_H = kc^3 A_H / (4\hbar G)$ and HAWKING temperature $T_H = \hbar c^3 / (8\pi kGM)$, one obtains the formula $T_H S_H M / A_H = (2/G)^2 (c/2)^6 / (2\pi)$. If one sets $T_H S_H = Q_H = E = Mc^2$ 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 $R = c/H_0$ yields $M = 8^{1/2} c^3 / (2^3 G H_0)$. $M = E/c^2$ 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.

With $H_0 = 2.285\cdot10^{-18}$ s^{-1} this results in the dark energy: 5.61×10^{69} J · 70 / 4 = $\underline{0.982\times10^{71} \text{ J}}$.
$H_0 = 70.5$ 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:

$$E = h \cdot \ln2 \cdot H/t \qquad (2.2)$$

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 $A = (h/k) S \rightarrow AT = (h/k) ST = (h/k) Q$.
$E = h\nu = kT \rightarrow T = h\nu / k$. $A h\nu / k = (h/k) Q \rightarrow A \nu = Q \rightarrow A/\tau = Q \rightarrow A = Q \tau \rightarrow Q \tau = (h/k) S$.
$S = k \cdot \ln2 \cdot H$ is given by $Q = h \cdot \ln2 \cdot H / \tau$.
If one then sets $\Delta t = a\tau$ (a = dimensionless factor), then $Q = h \cdot \ln2 \cdot a \cdot H / (a\tau) = h \cdot \ln2 \cdot a \cdot H / \Delta t \rightarrow$ $Q/a = h \cdot \ln2 \cdot H / \Delta t$. Q/a is Q_t, then $Q_t = h \cdot \ln2 \cdot H / \Delta t$. With $Q_t = E_t$ 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 H_K is given in THOMAS GÖRNITZ [8] as approx. 10^{122} bit for t_u = 15 billion years. From this, formula (3.2) calculates the cosmic information $H_K = 0.943\times10^{122}$ bit for t_u = 13.8 billion years. $H_K = 0.943\times10^{122}$ bit for the cosmic information and $t_u = 4.358\times10^{17}$ s yields
$\underline{E_d = 0.994\times10^{71} \text{ J}}$ 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

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

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

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

$$\ln2 \cdot H_k = (t_u / t_p)^2 \qquad (3.2)$$

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

The maximum possible information content H_{max}, which can encode the surface of a spherical universe and which corresponds to this surface in PLANCK units, is given by $A_u = 4\pi R^2 = 4\pi(R/l_p)^2$, (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

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

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

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

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

4. Calculation of dark matter

According to THOMAS GÖRNITZ, the number of AQIs (abstract quantum information) in the cosmos is $N = (t_u/t_p)^2 /2 = 0.32\times10^{122}$ [1, pg. 30]. This value corresponds to the value of dark matter in Table 1 on page 4, where $H_{DM} = 0.33\times10^{122}$ is given. That`s a remarkable match!
With formula (3.2) it follows:

$$H_K/N = 2/\ln2 \approx 2.89 \tag{4.1}$$

By comparing in Table 1 on page 4 the information equivalents of the dark energy $H_{DE} = H_K$ and the total mass energy of the universe H_u, one obtains the relation

$$H_{DE} = \ln2 \cdot H_u \tag{4.2}$$

and $E_d = (\ln2)^2 \cdot h \cdot H_u / t_u$. $\ln2 \cdot H_{DE} = (t_u / t_p)^2 \sim A_k$
The formulas (3.2), (4.1) and (4.9) lead to

$$H_{BH} = z_{BH} \cdot n_{BH} = (t_u/t_p)^2 /4 \tag{4.3}$$

By combining the different information equivalents of the energies in Table 1 on page 4, a number of formulas of the ratios of the information equivalents can be derived. Here are examples:

$$H_{max} / H_{DE} = 4\pi\, c^5\, t_p^2 / (\ln2 \cdot \hbar G) \tag{4.4}$$

$$H_{max} / H_M = 8^{3/2} \cdot \pi^2 \cdot \ln2 \tag{4.5}$$

The formulas (3.2) and (4.3) lead to

$$H_{BH} = H_{DE} \cdot \ln2/4 \tag{4.6}$$

$$H_{DE} / \ln2 \sim A_k \sim (t_u / t_p)^2$$

Formula (4.2) results in

$$4\, H_{BH} = H_{DE}^2 / H_u \tag{4.7}$$

and

$$H_{BH} = [(\ln2)^2 /4]\, H_u \tag{4.8}$$

According to THOMAS GÖRNITZ, the information equivalent of the total black holes in the universe is

$$H_{BH} = z_{BH} \cdot n_{BH} = N/2 \tag{4.9}$$

[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 GÖRNITZ).

5. Preparation of the balance sheet

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

	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)]	

Table 1: Mass energy and information balance of the universe

[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 on page 4.

Author	formula	determined	deducted further formulas
ISING, H. and PAGEL, L.	${}_IE = h\ H/t_u$	H_u	$E_d = h\ t_u/t_p^2$
JÖGE, F.	${}_JE = h \cdot \ln2 \cdot H/t_u$	H_{DE}	$\ln2 \cdot H_{DE} = (t_u/t_p)^2$
SEDLACEK, KL. -D. and GÖRNITZ, TH. [11, pg. 40]	${}_GE = (\ln2/12\pi^2)\ h\ H/t_u$ [2)]	H_{Neu}	$H_{DE} = (2 / \ln2)\ N$
			$H_{DM}^2 = (H_{BH} \cdot H_u) / 2$
	$E_M = c^5 /(8^{1/2}\ GH_0)$	H_M	$H_{DE} = \ln2\ H_u$
	$H_{DM} = (t_u/t_p)^2 /2 = H_u /4$	$H_{DM} = N$	$H_{max}/H_M = 8^{3/2}\ \pi^2 \ln2$
	$H_{max} = 4\pi^2\ c^5\ t_u^2/(\hbar G)$	H_{max}	$H_{BH} = (\ln2/4)\ H_{DE}$
	$H_{BH} = (t_u/t_p)^2 /4$	H_{BH}	$H_{BH} = H_u / 8 = [(\ln2)^2/4]\ H_u$
			$H_{BH} = N/2 = H_{DM} /2$

Table 2: Compilation of the most important formulas

[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 information 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 information equivalent of the black holes in the cosmos is equal to $H_{DM} / 2 = H_u / 8 = [(\ln 2)^2/4]\, H_u$. 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
A_H = area of the black hole event horizon measures the information potentially contained in it
A_u = surface of the spherical universe, corresponding to H_u
A_k = surface of the spherical universe, corresponding to H_k
AQI = abstract quantum information (protyposis)
R = cosmic radius
c = speed of light
ν = frequency
E = energy
G = constant of gravitation
H_0 = HUBBLE constant
H = SHANNON information entropy
H_{BH} = information equivalent of the total mass energy of the number of black holes in the cosmos
H_{DE} = information equivalent of dark energy
H_{DM} = information equivalent of dark matter
H_K = cosmic information, $H_K = H_{DE}$
H_{Neu} = information equivalent of neutrinos
H_u = information equivalent of the total mass energy of the universe
h = PLANCK quantum of action, $\hbar = h/(2\pi)$
k = BOLTZMANN constant
M = mass
M_{DM} = mass of dark matter
M_{KG} = cosmic total mass
M_M = mass of visible baryonic matter
N = number of AQIs in the cosmos
n_{BH} = number of AQIs for a black hole
p = pressure
Q = thermal energy
S = thermodynamic entropy
S_H = BEKENSTEIN HAWKING entropy
T = absolute temperature
τ = period of oscillation
t = time
t_u = age of the universe
t_p = PLANCK time
l_p = PLANCK length
U = internal energy
V = volume
z_{BH} = number of black holes in the cosmos (THOMAS GÖRNITZ [1])

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