Calculation of Dark Energy and Dark Matter

Friedhelm M. Jöge[1]

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 for the frequencies of the spectral lines in the arc spectrum of hydrogen was also theoretically justified by NIELS BOHR, who calculated the energy levels of the hydrogen atom and the fequencies of spectral lines.

Summary

The derivation of a formula for calculation 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.

Keywords: Dark energy, dark matter, PLANCK time, age of the universe, cosmic information.

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:

$_pE_d = h / t_p = 1.229 \times 10^{10}$ J in PLANCK time
$_1E_d = 2.28 \times 10^{53}$ J in 1 s
$\underline{E_d = 0.994 \times 10^{71}}$ J in 13.8 billion years for the age of the universe $t_u = 4.358 \times 10^{17}$ s

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

$$E_d = h \, t_u / t_p^2 \tag{1.2}$$

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.

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[1] Schulstrasse 57, D-31812 Bad Pyrmont, Germany, E-Mail: f.joege@web.de

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 deduced 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) $S_H = k c^3 A_H / (4\hbar G)$ and HAWKING temperature $T_H = \hbar c^3 / (8\pi k G M)$, one obtains the formula $T_H S_H M / A_H = (2/G)^2 (c/2)^6 / (2\pi)$. If one sets $T_H S_H = Q_H = E = M c^2$ 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 $M^2 c^2 / (4\pi R^2) = 4 c^6 / (2^6 G^2 2\pi)$ 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

$$E_M = c^5 / (8^{1/2} G H_0) = 5.61 \times 10^{69} \text{ J} \qquad (2.1)$$

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
$H_0 = 2.285 \times 10^{-18} \text{ s}^{-1}$ this results in the dark energy: $5.61 \times 10^{69} \text{ J} \cdot 70 / 4 = \underline{0.982 \times 10^{71} \text{ J}}$.

$H_0 = 70.5 \text{ km s}^{-1} \text{ Mpc}^{-1}$ 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 deduced exactly here from the DE BROGLIE formula [7]:

The DE BROGLIE formula is: $A/h = S/k$. This results in $A = (h/k) S \rightarrow AT = (h/k) ST = (h/k) Q$. $E = h\nu = kT \rightarrow T = h\nu / k$. $A h\nu / k = (h/k) Q \rightarrow A \nu = Q \rightarrow A/\tau = Q \rightarrow A = Q \tau \rightarrow Q \tau = (h/k) S$. $S = k \cdot \ln 2 \cdot H$ is given by $Q = h \cdot \ln 2 \cdot H / \tau$.

If one then sets $\Delta t = a\tau$ (a = dimensionless factor), then $Q = h \cdot \ln 2 \cdot a \cdot H / (a\tau) = h \cdot \ln 2 \cdot a \cdot H / \Delta t \rightarrow Q/a = h \cdot \ln 2 \cdot H / \Delta t$. Q/a is Q_t, then $Q_t = h \cdot \ln 2 \cdot H / \Delta t$. 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 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

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

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)

$$ln2 \cdot Hk = (tu / tp)^2 \tag{3.2}$$

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 $A_u = 4\pi R^2 = 4\pi (R/l_p)^2$. (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

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

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

This value is in good agreement with the one identified by R. PENROSE [10]. *For comparison*, the BEKENSTEIN-HAWKING entropy is cited: $S_H = kc^3 \, AH/(4\hbar G)$; with SH = k $\cdot$ ln2 $\cdot$ HH 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 GORNITZ, the number of AQIs (abstract quantum information) in the cosmos is N = $t_{cosmos}^2 \, / \, 2 = (tu/tp)^2 \, /2 = 0.32 \times 10^{122}$ [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:

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

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

$$HDE = ln2 \cdot Hu \tag{4.2}$$

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

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

$$HBH = zBH \cdot nBH = (tu/tp)^2 \, /4 \tag{4.3}$$

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:

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

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

The formulas (3.2) and (4.3) lead to

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

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

Formula (4.2) results in

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

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

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

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

The number of AQIs that make up all black holes in the universe is therefore $N/2 = 0.3268 \times 10^{122} /2 = 0.1634 \times 10^{122}$. 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 $M_{KG} = 5.5 \times 10^{53}$ 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.	$_IE = h\, H/t_u$	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	$H_{DE} = \ln2\, H_u$
	$H_{DM} = (t_u/t_p)^2 /2 = H_u /4$	$H_{DM} = N$	$H_{max}/H_M \approx 8^{3/2}\, \pi^2 \ln2$
	$H_{max} = 4\pi\, c^5\, t_u^2/(\hbar G)$	H_{max}	$H_{BH} = (\ln2/4)\, H_{DE}$
	$H_{BH} = (t_u/t_p)^2 /4$	H_{BH}	$H_{BH} = H_u / 8 = [(\ln2)^2/4]\, Hu$
			$H_{BH} = N/2 = H_{DM} /2$

[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 $8^{3/2} \cdot \pi^2 \cdot \ln2$. The informational equivalent of the black holes in the cosmos is equal to HDM / 2 = Hu /8 = $[(\ln2)^2/4]$ 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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