Dark Energy generated by the Evolutionpotential

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Abstract

In this paper i will give an explanation for the source of dark energy by a potential which is responsible for the expansion of the universe.I show that the gowth process is very easy to understand like the rabbit population growth described by Fibonacci. At the end of the paper i will give some hints why i have choosen this form of the potential.

Keywords: *dark energy; cosmic inflation;universe; golden mean;golden ratio*

1. Introduction

Georges Lemaître discovered Juni 1927 based on the redshift of the galaxies that the universe is expanding.In Einsteins general relativity the expansions comes from the cosmological constant Λ which is a constant factor in the equation.But until today nobody knows what is the reason for that factor.Some say the reason is the vacuumfluctuation but this leads to the vacuum catastrophe.I want to give an answer by the Evolutionpotential which is conform to Einsteins equations and easily shows why the universe is expanding.

1.1. The Evolution Equation

The equation is an energydensitypotential with speed as variable.

$$V(\phi) = (\frac{\Lambda.c^4}{8\pi G})^2. \left(-\frac{\varphi^3}{\varphi^3+1}(\frac{\mid \phi \mid}{c})^2 + (\frac{\mid \phi \mid}{c})^4 - \frac{1}{\varphi^3+1}(\frac{\mid \phi \mid}{c})^8 \right) \tag{1}$$

$speed\ \phi \in \mathbb{O}^5 \times i\mathbb{R}^8 \ = Octonions^5 \times Imaginaers^8$
$c ...speed\ of\ light$
$\Lambda ...\ cosmological\ constant$
$G ...gravitation\ constant$
$\varphi ...golden\ mean\ 1,618033...$

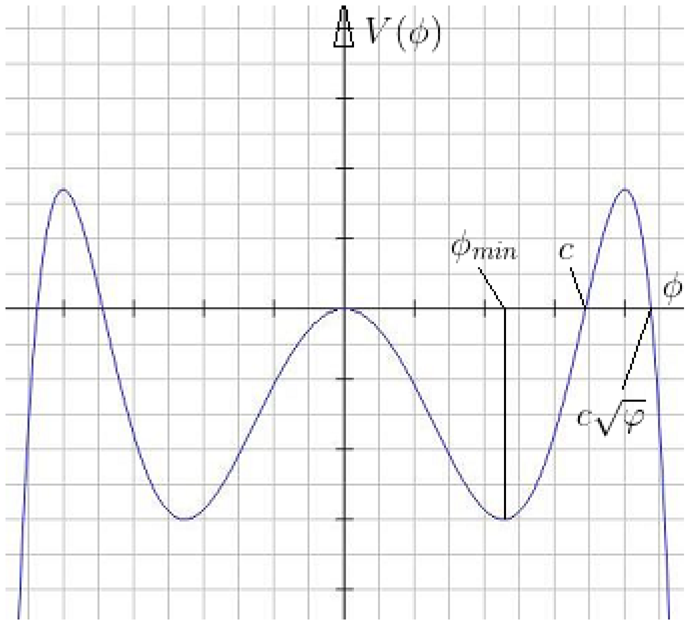
representation of the definitionrange as (extented) octonionic vector $\phi =$

$$\begin{pmatrix} (\phi_{2\bar{1}} + i\phi_0).1 & +\phi_{01}i_1 & +\phi_{02}i_2 & +\phi_{03}i_3 & +\phi_{\bar{2}1}i_4 & +\phi_{\bar{2}3}i_5 & +\phi_{\bar{2}4}i_6 & +\phi_{\bar{2}5}i_7 \\ \phi_{10}.1 & +(\phi_{3\bar{1}} + i\phi_1).i_1 & +\phi_{12}i_2 & +\phi_{13}i_3 & +\phi_{\bar{3}2}i_4 & +\phi_{\bar{3}1}i_5 & +\phi_{\bar{3}4}i_6 & +\phi_{\bar{3}5}i_7 \\ \phi_{20}.1 & +\phi_{21}i_1 & +(\phi_{4\bar{1}} + i\phi_2).i_2 & +\phi_{23}i_3 & +\phi_{\bar{4}2}i_4 & +\phi_{\bar{4}3}i_5 & +\phi_{\bar{4}1}i_6 & +\phi_{\bar{4}5}i_7 \\ \phi_{30}.1 & +\phi_{31}i_1 & +\phi_{32}i_2 & +(\phi_{5\bar{1}} + i\phi_3).i_3 & +\phi_{\bar{5}2}i_4 & +\phi_{\bar{5}3}i_5 & +\phi_{\bar{5}4}i_6 & +\phi_{\bar{5}1}i_7 \\ (\phi_{00} + i\phi_{\overline{00}}).1 & +(\phi_{11} + i\phi_{\overline{11}}).i_1 & +(\phi_{22} + i\phi_{\overline{22}}).i_2 & +(\phi_{33} + i\phi_{\overline{33}}).i_3 & +\phi_{44}i_4 & +\phi_{55}i_5 & +\phi_{66}i_6 & +\phi_{77}i_7 \end{pmatrix} \quad (2)$$

with $\phi_{xx} \in \mathbb{R}$
Dimension of the definitionrange = 5 x 8 + 8 = 48

More information about the definitionrange DOF see references [KR01]

1.2. Picture of the equation



the potential is zero on the spheres or shells
$\mid \phi \mid = 0$
$\mid \phi \mid = c$
$\mid \phi \mid = c\sqrt{\varphi}$

With basic mathematic like Cardaniac formular and so on we can calculate the value ϕ_{min} where the potential is a minima.
To get the value for the minima we have to calculate the zeropoints of a cubic equation.
The real zeropoints of cubic equations comes from a rotation therefore we have an angle α_{min} in the solution.
I just want to give the exact result here.

$\phi_{min} = c.sin(\alpha_{min}).\sqrt[4]{\frac{4\varphi^2}{3}} \approx c.0,6604642002662$
with
$\alpha_{min} = arcsin(\sqrt{cos(\frac{arccos(\sqrt{\frac{3}{4}}^3)+\pi}{3})}) \approx 28,9^o$

$\alpha_{min} \approx \theta_W \quad measured\ Weinberg\ angle$

$sin^2(\alpha_{min}) \approx 0,23347$

1.3. Understanding the 3 terms of the equation

The potential $V(\phi)$ is a $energydensity^2$ and on the zeropoint c (speed of light) we can write it as

$$E^2 = p^2.c^2 + \varrho^2.c^4 + \sigma^2.c^8 = 0 \tag{3}$$

$E...energydensity$
$p...(pressure/c)$
$\varrho...massdensity$
$\sigma...stretchdensity$

Comparing equation (2) with equation (1) on $\phi = c$ we get

$$p^2.c^2 = -\frac{\varphi^3}{\varphi^3+1}(\frac{\mid c \mid}{c})^2(\frac{\Lambda.c^4}{8\pi G})^2 \tag{4}$$

$$\varrho^2.c^4 = 1.(\frac{\mid c \mid}{c})^4(\frac{\Lambda.c^4}{8\pi G})^2 \tag{5}$$

and

$$\sigma^2.c^8 = -\frac{1}{\varphi^3+1}(\frac{\mid c \mid}{c})^8(\frac{\Lambda.c^4}{8\pi G})^2 \tag{6}$$

1.4. Understanding the Evolutionpotential as growth process

To see it more clear we write equation (1) in the following shape
with

$$\frac{c^4}{G} = P_p.l_p^2 \tag{7}$$

$P_p...\ Planckpressure$
$l_p...\ Plancklength$

we get

$$V(\phi) = (\frac{1}{4}\frac{P_p.\Lambda.l_p^2}{2\pi})^2.\left(-\frac{\varphi^3}{\varphi^3+1}(\frac{\mid\phi\mid}{c})^2 + (\frac{\mid\phi\mid}{c})^4 - \frac{1}{\varphi^3+1}(\frac{\mid\phi\mid}{c})^8\right) \tag{8}$$

we write for short

$$\frac{\Lambda.l_p^2}{4} = \frac{1}{N^2} \approx \frac{0,65}{10^{122}} \approx \frac{1}{48!^2} \qquad Permutationfactor\ dimensionless \tag{9}$$

we set G=ℏ=c=1 (natural units) and assume that $\approx$ is $=$ then we get

$$V(\phi) = \frac{1}{48!^4}.\frac{1}{(2\pi)^2}.\left(-\frac{\varphi^3}{\varphi^3+1}\mid\phi\mid^2 + 1.\mid\phi\mid^4 - \frac{1}{\varphi^3+1}\mid\phi\mid^8\right) \tag{10}$$

Reading the formular:
We see for smaller N the negative pressure is bigger and getting smaller for big N.
This means in the first time of the universe N was small and therefore the expanding big (cosmic inflation).Now N is very big and therefore the expanding small.
N is the count of permutations of the definition range for the Evolutionpotential.
For example the Higgsfield have 4 degrees of freedome therefore N= 4!=24
Our Potential is defined over *speed* $\phi \in \mathbb{O}^5 \times i\mathbb{R}^8$ and therefore has $5.8 + 8 = 48$ degrees of freedome.Then $N = 48! \approx 1,24.10^{61}$.
We can see clear that the pressure which expands the universe is so small because we have a lot of degrees of freedome on the definition range.
One side result of this is see (9) that

$$\frac{\Lambda.l_p^2}{4} = \frac{1}{48!^2} \tag{11}$$

For describing the growth process we write the formular (10) as follow.

$$V(1) = \frac{1}{N^4}.\frac{1}{(2\pi)^2}.\left(-\frac{\varphi^3}{\varphi^3+1^3}.\frac{1}{1} + \frac{\varphi^3+1^3}{\varphi^3+1^3}.\frac{1}{1} - \frac{1^3}{\varphi^3+1^3}.\frac{1}{1}\right) = 0 \tag{12}$$

In our potential we have *densities*^{2} (*massdensity*^{2},...) so the third power comes from the 3 spacedimensions ($Volumne^2$).

Then we can write (12) as follow.

$$V(1) = \frac{1}{N^4}.\frac{1}{(2\pi)^2}.\left(-\frac{\Theta_{\sqrt{\varphi}}^2}{\Theta_{\sqrt{\varphi}}^2+\Theta_{\sqrt{1}}^2}.\frac{\sqrt{1}^2}{\sqrt{1}^2} + \frac{\Theta_{\sqrt{\varphi}}^2+\Theta_{\sqrt{1}}^2}{\Theta_{\sqrt{\varphi}}+\Theta_{\sqrt{1}}}.\frac{\sqrt{1}^2}{\sqrt{1}^2} - \frac{\Theta_{\sqrt{1}}^2}{\Theta_{\sqrt{\varphi}}^2+\Theta_{\sqrt{1}}^2}.\frac{\sqrt{1}^2}{\sqrt{1}^2}\right) = 0 \tag{13}$$

with

$$\Theta_{\sqrt{\varphi}} = (\sqrt{\varphi}.l_p)^3 = \sqrt{\varphi}^3 \quad \textit{volumne in natural units} \tag{14}$$

and

$$\Theta_{\sqrt{1}} = (\sqrt{1}.l_p)^3 = \sqrt{1}^3 \quad \textit{volumne in natural units} \tag{15}$$

drawing the 1^2 which can be seen as t_p^2 because we have $\frac{speed}{speed}$ in (13) inside the denominator and the numerator we get

$$V(1) = \frac{1}{N^4}.\frac{1}{(2\pi)^2}.\left(-\frac{M_{\sqrt{\varphi}}^2}{M_{\sqrt{\varphi}}^2+M_{\sqrt{1}}^2} + \frac{M_{\sqrt{\varphi}}^2+M_{\sqrt{1}}^2}{M_{\sqrt{\varphi}}+M_{\sqrt{1}}} - \frac{M_{\sqrt{1}}^2}{M_{\sqrt{\varphi}}^2+M_{\sqrt{1}}^2}\right) = 0 \tag{16}$$

with

$$M_{\sqrt{\varphi}} = (\sqrt{\varphi}.l_p)^3.t_p = \sqrt{\varphi}^3.1 \quad \textit{"volumne" of minkowski spacetime in natural units} \tag{17}$$

and

$$M_{\sqrt{1}} = (\sqrt{1}.l_p)^3.t_p = \sqrt{1}^3.1 \quad \textit{"volumne" of minkowski spacetime in natural units} \tag{18}$$

The most important growth process in nature is the Fibonacci series.

$$F_n = F_{n-1} + F_{n-2} \tag{19}$$

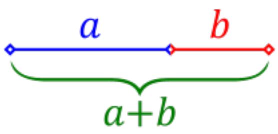
$n \geqslant 3$
$F_1 = F_2 = 1$

This leads to the golden mean growth process the golden mean series

$$\varphi^n = \varphi^{n-1} + \varphi^{n-2} \tag{20}$$

φ*...golden mean*
$\varphi = 1,618...$

The important property of the golden mean is if $a = 1$ *and* $a + b = \varphi$ that



This leads to the fact that the golden mean series is selfsimilar.

$$\frac{a_n}{a_{n-1}} = \varphi \tag{21}$$

Now we want to transform the golden mean series (20) to the shape of our potential (12).
With the formular

$$2\varphi^{n+2} = \varphi^{n+3} + \varphi^n \tag{22}$$

which is equvalent to (20) because of

$$\varphi^{n+3} = \varphi^{n+2} + \varphi^{n+2} - \varphi^n = \varphi^{n+2} + \varphi^{n+1} + \varphi^n - \varphi^n = \varphi^{n+2} + \varphi^{n+1} \tag{23}$$

divide (22) by φ^n leads to

$$2\varphi^2 = \varphi^3 + 1 = \varphi^3 + 1^3 \tag{24}$$

then

$$-\varphi^3 + 2\varphi^2 - 1 = 0 \tag{25}$$

divide by $2\varphi^2 = \varphi^3 + 1$ leads to

$$-\frac{\varphi^3}{\varphi^3 + 1} + 1 - \frac{1}{\varphi^3 + 1} = 0 \tag{26}$$

divide by $\frac{1}{N^4} \cdot \frac{1}{(2\pi)^2}$ leads to

$$V(1) = \frac{1}{N^4} \cdot \frac{1}{(2\pi)^2} \cdot \left(-\frac{\varphi^3}{\varphi^3 + 1^3} \cdot \frac{1}{1} + \frac{\varphi^3 + 1^3}{\varphi^3 + 1^3} \cdot \frac{1}{1} - \frac{1^3}{\varphi^3 + 1^3} \cdot \frac{1}{1} \right) = 0 \tag{27}$$

This is the formular which is the same as our potential (12) deduced by the golden mean growth.
Important hint:The golden mean growth here is not the growth in time!This means the space
is not growing by the golden mean in time!

1.5. understanding the normingfactors on the Evolutionpotential shape (10)

We know such factors in mathematics and physics when something must be normed or from statistics when something is (in)distinguishable and so on.
The number 48 is the count of the degrees of freedome on the definitionrange of our potential.Therefore the factor comes from the permutations of this degrees of freedome.
We take equation (12) and draw the factor $\frac{1}{N^4} = \frac{1}{48!^4}$ inside the brackets to see it more clear.

$$V(1) = \frac{1}{N^4} \cdot \frac{1}{(2\pi)^2} \cdot \left(-\frac{\varphi^3}{\varphi^3 + 1^3} \cdot \frac{1}{1} + \frac{\varphi^3 + 1^3}{\varphi^3 + 1^3} \cdot \frac{1}{1} - \frac{1^3}{\varphi^3 + 1^3} \cdot \frac{1}{1} \right) = 0 \tag{28}$$

then we get with

$$V(1) = \frac{1}{(2\pi)^2} \cdot \frac{1}{\varphi^3 + 1^3} \cdot \left(-\frac{\varphi^3}{N^3} \cdot \frac{1}{N} + 2 . \frac{\varphi^2}{N^2} \cdot \frac{1}{N} \cdot \frac{1}{N} - \frac{1^3}{N^3} \cdot \frac{1}{N} \right) = 0 \tag{29}$$

As we have seen on (13) we have $volmne^2$ in the formular therefore we write it to

$$V(1) = \frac{1}{(2\pi)^2} \cdot \frac{1}{\varphi^3 + 1^3} \cdot \left(-(\frac{\sqrt{\varphi}}{\sqrt{N}} \cdot \frac{\sqrt{\varphi}}{\sqrt{N}} \cdot \frac{\sqrt{\varphi}}{\sqrt{N}} \cdot \frac{\sqrt{1}}{\sqrt{N}})^2 + 2.(\frac{\sqrt{\varphi}}{\sqrt{N}} \cdot \frac{\sqrt{\varphi}}{\sqrt{N}} \cdot \frac{\sqrt{1}}{\sqrt{N}} \cdot \frac{\sqrt{1}}{\sqrt{N}})^2 - (\frac{\sqrt{1}}{\sqrt{N}} \cdot \frac{\sqrt{1}}{\sqrt{N}} \cdot \frac{\sqrt{1}}{\sqrt{N}} \cdot \frac{\sqrt{1}}{\sqrt{N}})^2 \right) \tag{30}$$

Each of the 3 terms is a squared 4 dimensional volumne.
Taking a look on one term we have as multiplier the factor $\frac{1}{\sqrt{N}} = \frac{1}{\sqrt{48!}}$ which remember us on the normalizationfactor of the Slater determinant and the the sum of squared volumnes remember us on the Gram determinant (see references at the end).
We write equation (10) in the Gram-form

$$V(\phi) = (\frac{1}{48!\sqrt{2\pi}})^4 \cdot \frac{1}{\varphi^3 + 1^3} . det(G) = (\frac{1}{48!\sqrt{2\pi}})^4 \cdot \frac{1}{\varphi^3 + 1^3} \begin{vmatrix} \mid \phi \mid^2 & 0 & 0 & 0 \\ 0 & 2\varphi & \mid \phi \mid^2 & \varphi \\ 0 & \mid \phi \mid^2 & \varphi & 0 \\ 0 & \varphi & 0 & \mid \phi \mid^2 \end{vmatrix} \tag{31}$$

The factor $\frac{1}{\sqrt{2\pi}}$ remember us on the Gauss Normaldistribution (see references), delta distribution and Fouriertransformations.

$$f(\sigma, x) = \frac{1}{\sqrt{2\pi\sigma^2}} . e^{-\frac{1}{2} \cdot (\frac{x}{\sigma})^2} \tag{32}$$

with σ is its standard deviation (average quadratic deviation) and mean $= 0$.
$\frac{1}{\sqrt{2\pi\sigma^2}}$ is the normingfactor of the distribution.

The normed wave function to this distribution is

$$\psi(\sigma, x) = \frac{1}{\sqrt[4]{2\pi\sigma^2}} . e^{-\frac{iP_0 \cdot x}{\hbar}} . e^{-\frac{1}{4} \cdot (\frac{x}{\sigma})^2} \tag{33}$$

with

$$f(\sigma, x) = \psi(\sigma, x) . \psi^*(\sigma, x) = \mid \psi(\sigma, x) \mid^2 \tag{34}$$

We assume because of the normingfactor $\frac{1}{\sqrt{2\pi}}$ which appears in the equation (31) that the 48 degrees of freedome of the definitionrange $\{\phi_1, ..., \phi_{48}\}$ see (1.1.) are identical independend short iid normal distributed $\phi_1, ..., \phi_{48} \sim \mathcal{N}(0, 1)$.

In our equation (30) we have squared speeds this means that our focus must be on the Chi-squared distribution which is derived from the normal distribution.
In one degree of freedome this means if ϕ_i is normal distributed then $z_i = \phi_i^2$ is Chi-squared distributed.Formal $z_i = \phi_i^2 \sim \chi(1)$ see references at the end.
For one degree of freedome the Chi-squared distribution is:

$$f(z_i) = \frac{1}{\sqrt{2\pi}} \cdot \frac{e^{-\frac{z_i}{2}}}{\sqrt{z_i}} \tag{35}$$

The expectation value $E(z_i) = 1 = c^2 \quad c...speed\ of\ light$
The speed of light follows naturally as expectationvalue by the Chi-squared distribution.

The normed wave function to this distribution is:

$$\psi(z_i) = \frac{1}{\sqrt[4]{2\pi}} \cdot \frac{e^{-\frac{z_i}{4}.(1+i.4K)}}{\sqrt[4]{z_i}} \tag{36}$$

$1 \leq i \leq 48 \quad K...constant$

But in our equation (1) which is identical to (31) under assumption (11) there is no wavefunction or distribution?
But if we replace the speed observable ϕ by the speedoperator $\hat{\phi}$ in our speed definition range of the equation (1) and (31) then we can easily see why we have wavecomponents in our equation (1) and (31).
The speedvalues $\phi_0 \in \mathbb{R}$ then are the eigenvalues of the speedoperator with deltadistributions as eigenfunctions.

$\hat{\phi}\delta(\phi - \phi_0) = \phi_0\delta(\phi - \phi_0)$

By superposition we can build the wavefunction (33) easily

$\psi(\phi) = \int \psi(\phi_0)\delta(\phi - \phi_0).d\phi_0$

with $\psi(\phi_0)d\phi_0$ as the weight of the value ϕ_0

So finally without exact proof we interprete the normingfactor in front of the determinant on equation (31) as follow.

$$(\frac{1}{48!})^4.(\frac{1}{\sqrt{2\pi}})^4.\frac{1}{\varphi^3 + 1^3} \tag{37}$$

$\frac{1}{48!}$ Approach:
Every of the 48 degrees of freedome we can assign a wavefunction $\psi_i(\phi)$ like on (33).
We know from the theory that the wavefunction for indistinguishable particles (our excited degrees) is normed by $\frac{1}{\sqrt{48!}}$.
Such a wavefunction for bosons where P is a Permutation of the 48 degrees is:

$$\Psi(1, ..., 48) = \frac{1}{\sqrt{48!}} \sum_{P \in S_{48}} \psi_1(P(1))...\psi_{48}(P(48)) \tag{38}$$

Then the normingfactor for the distribution (34) of this wavefunction is $\frac{1}{48!}$.

$\frac{1}{\sqrt{2\pi}}$ is the norming factor of the Chi-squared distribution on every degree of freedome.

$\frac{1}{\varphi^3+1^3}$ is norming the positiv squared volumne and the negative squared volumnes.

1.6. conformity with the energy-momentum tensor

We show that our potential leads to the energy-momentum equation

$$\frac{8\pi G}{c^4} T_{\mu\nu} = \Lambda.\eta_{\mu\nu} \tag{39}$$

$\eta_{\mu\nu}$*...flat spacetime metric*
Λ*... cosmological constant*
$T_{\mu\nu}$*... energy − momentum tensor*

For that we input the 3 terms of equation (3) in the following manner into the energy-momentum tensor

$$\frac{8\pi G}{c^4} T_{\mu\nu} = \frac{8\pi G}{c^4} \begin{pmatrix} \sqrt{\varrho^2.c^4} & 0 & 0 & 0 \\ 0 & -\sqrt{\mid p^2.c^2+\sigma^2.c^8 \mid} & 0 & 0 \\ 0 & 0 & -\sqrt{\mid p^2.c^2+\sigma^2.c^8 \mid} & 0 \\ 0 & 0 & 0 & -\sqrt{\mid p^2.c^2+\sigma^2.c^8 \mid} \end{pmatrix} \tag{40}$$

Using equation (4),(5),(6) we get what we want to show

$$\frac{8\pi G}{c^4} T_{\mu\nu} = \frac{8\pi G}{c^4} \begin{pmatrix} \frac{\Lambda.c^4}{8\pi G} & 0 & 0 & 0 \\ 0 & -\frac{\Lambda.c^4}{8\pi G} & 0 & 0 \\ 0 & 0 & -\frac{\Lambda.c^4}{8\pi G} & 0 \\ 0 & 0 & 0 & -\frac{\Lambda.c^4}{8\pi G} \end{pmatrix} = \Lambda \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix} \tag{41}$$

because $\mid p^2.c^2+\sigma^2.c^8 \mid = (\frac{\Lambda.c^4}{8\pi G})^2$

1.7. conformity with the empirical datas

We know from observations that the universe actually is growing by ≈ 70 *km per second* on a distance of 1 megaparsec $\approx\ 30,9.10^{18}\ km$.
This observation includes the gravity of the mass,radiation,...
The Evolutionpotential is only the dark energy part of the expansion.
First i have to say that the Evolutionpotential is conform with the empirical datas by definition because we have set the second term as the massdensity which is given by the cosmological constant and the value of this constant comes from empirical measurements.
I only show in the next part that with assumption (11) we come to the same results and where we see the expansion in our Evolutionpotential.

We know from the Friedmann equation that the Hubble-Parameter for the dark energy is

$$H^2 = \frac{\Lambda}{3}.c^2 \tag{42}$$

with the assumption in (11) we can write it

$$H^2 = \frac{4.c^2}{3.l_p^2.48!^2} = \frac{4}{3.48!^2} \quad in\ natural\ units \tag{43}$$

Then 2 objects (galaxies) with a distance of D walk away by the velocity of

$$v = H.D \tag{44}$$

Then the distance is growing by a $\triangle$ in a Plancktime

$$\triangle = v.t_p = H.D_0.t_p = D_0.\frac{1}{\sqrt{3}}\frac{2}{48!} \quad in\ natural\ units \tag{45}$$

Then the new distance after a Plancktime is

$$D_1 = D_0 + D_0.\frac{1}{\sqrt{3}}\frac{2}{48!} = D_0(1 + \frac{1}{\sqrt{3}}\frac{2}{48!}) \quad in\ natural\ units \tag{46}$$

Then the new distance after another Plancktime is

$$D_2 = D_1 + D_1.\frac{1}{\sqrt{3}}\frac{2}{48!} = D_1(1 + \frac{1}{\sqrt{3}}\frac{2}{48!}) = D_0(1 + \frac{1}{\sqrt{3}}\frac{2}{48!})^2 \quad and\ so\ on \tag{47}$$

Then in general the distance after n Plancktimes is

$$D_n = D_0(1 + \frac{1}{\sqrt{3}}\frac{2}{48!})^n \tag{48}$$

On a distance of D_0 =1 Megaparsec $\approx 30,9.10^{18}km$ we have a growth after 1 second $\approx 0,1855.10^{44}\ t_p$

$$D_n = D_0(1 + \frac{1}{\sqrt{3}}\frac{2}{48!})^{0,1855.10^{44}} = D_0(1 + \frac{1}{\sqrt{3}}\frac{2}{48!})^{\frac{0,1855.10^{44}}{\frac{1}{\sqrt{3}}\frac{2}{48!}}\frac{1}{\sqrt{3}}\frac{2}{48!}} = \tag{49}$$

$$D_n = D_0((1 + \frac{1}{\sqrt{3}}\frac{2}{48!})^{\frac{\sqrt{3}48!}{2}})^{0,1855.10^{44}\frac{1}{\sqrt{3}}\frac{2}{48!}} \approx D_0 e^{0,1855.10^{44}\frac{1}{\sqrt{3}}\frac{2}{48!}} \tag{50}$$

$$\approx D_0.(1 + 0,1855.10^{44}\frac{1}{\sqrt{3}}\frac{2}{48!}) \tag{51}$$

because $(1 + \frac{1}{k})^k \to e\ for\ k \to \infty$ and $e^x \approx 1 + x$ for very small x.

Then with $48! \approx 1,24139.10^{61}$ we get finally

$$D_n \approx D_0(1 + \frac{1,7254}{10^{18}}) \tag{52}$$

with $n = 0,1855.10^{44} \widehat{=} 1 second$

The empirical expansion today is $\approx$ 70 km per 30,9 megapersec

$$D_n \approx D_0(1 + \frac{70}{30,9.10^{18}}) \approx D_0(1 + \frac{2,26}{10^{18}}) \tag{53}$$

The reason why our expansion is smaller is because we only have took into account the dark energy and not the mass,radiation,... in the universe.
Now we want to show that our Evolutionpotential leads to the same result.

For that we split the pressurecoefficient in equation (1) into two parts.

$$V(\phi) = (\frac{\Lambda.c^4}{8\pi G})^2.(...) = (\frac{\Lambda.c^2}{3})^2 \times \left(\frac{3.c^2}{8\pi G}\right)^2 (...) = H^4 \times \left(\frac{3.c^2}{8\pi G}\right)^2 (...) = \tag{54}$$

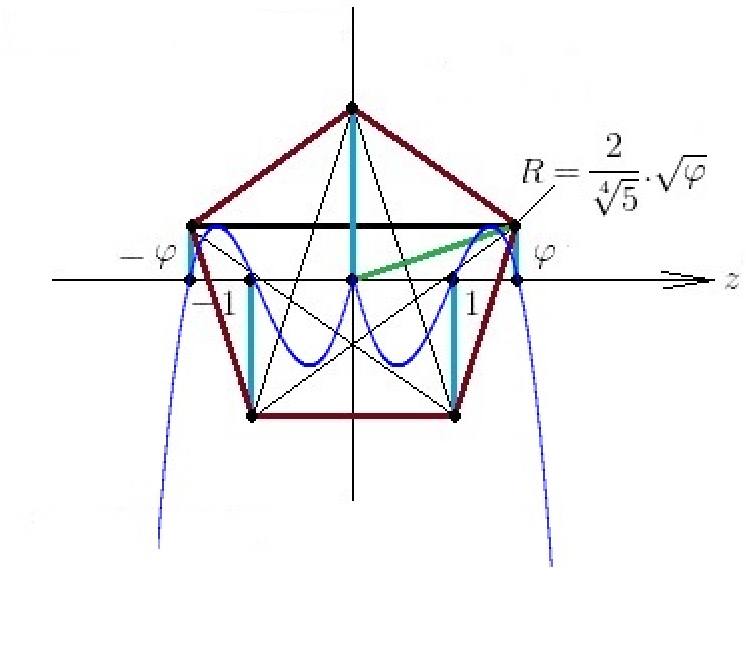
In natural units and with assumption (38) then it can be written as

$$V(\phi) = H^4 \times \left(\frac{3}{8\pi}\right)^2 (...) = (\frac{4}{48!^2}\frac{1}{3})^2 \times \left(\frac{3}{8\pi}\right)^2 (...) = \frac{1}{48!^4}.\frac{1}{(2\pi)^2}(...) \tag{55}$$

so it is easy to sea how the Hubbleparameter appears in the Evolutionpotential.
We keep in mind that it is the Hubbleparameter just for the dark energy!

1.8. the Evolutionpotential and the pentagon polygon

The square of the 5 zeropoints of the evolutionpotential belongs to a pentagon.
If we substitute $| \phi |^2 = | z |$ on the Evolutionpotential then we get the blue graph where the zeropoints can be generated by a pentagon.
This is just the squared stretching of the Evolutionpotential.



1.9. direct connection between Evolutionpotential and Kepler triangle

We start with some basics.For two positive numbers a and b we can calculate the three Pythagorean means:

$$\bar{A} = \frac{a+b}{2} \qquad \textit{arithmetic mean} \tag{56}$$

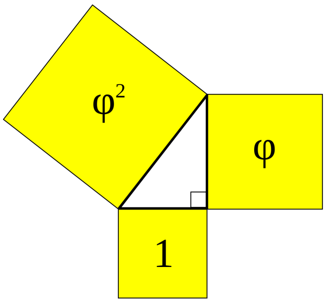
$$\bar{G} = \sqrt{a.b} \qquad \textit{geometric mean} \tag{57}$$

$$\bar{H} = 2\frac{a.b}{a+b} \qquad \textit{harmonic mean} \tag{58}$$

with

$$\bar{H} \leq \bar{G} \leq \bar{A} \tag{59}$$

The Kepler triangle with sides $\varphi, \sqrt{\varphi}$ *and* 1 where φ...golden mean.

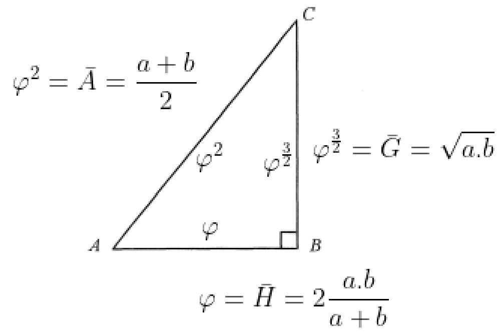


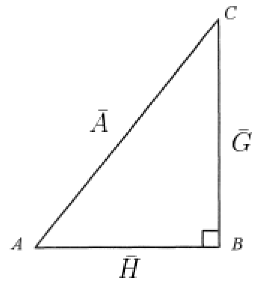
But this is not the only Kepler triangle.Every streching of all three sides by a factor x is also a Kepler triangle. We set our focus to the Kepler triangle with sides $\varphi, \varphi^{\frac{3}{2}}$ *and* φ^2 which is a stretching of the above triangle by the factor φ.

It is a known theorem that the Pythagorean means can be assigned to a right triangle $\Longleftrightarrow$ if it is a Kepler triangle and then a and b are in the relation (see references).

$$a = b.\varphi^3 \tag{60}$$

We choose $b = 1$ and then $a = \varphi^3$





$a = \varphi^3 \quad b = 1$

Then it is easy to see that we can write our Evolutionpotential (1) in the following shape:

$$V(\phi) = (\frac{\Lambda.c^4}{8\pi G})^2.\frac{1}{2}\left(-\bar{H}(\frac{\mid\phi\mid}{c})^2 + (\bar{H} + \frac{1}{\bar{A}})(\frac{\mid\phi\mid}{c})^4 - \frac{1}{\bar{A}}(\frac{\mid\phi\mid}{c})^8\right) \tag{61}$$

and with the known relation of the reciprocal dual (see references)

$$\bar{H}^{-1} := \bar{H}(\frac{1}{a},\frac{1}{b}) = \frac{1}{\bar{A}(a,b)} \tag{62}$$

$b = 1$ and $a = \varphi^3$

we get our potential in terms of the harmonic mean

$$V(\phi) = (\frac{\Lambda.c^4}{8\pi G})^2.\frac{1}{2}\left(-\bar{H}(\frac{\mid\phi\mid}{c})^2 + (\bar{H} + \bar{H}^{-1})(\frac{\mid\phi\mid}{c})^4 - \bar{H}^{-1}(\frac{\mid\phi\mid}{c})^8\right) \tag{63}$$

it is easy to proof that

$$(\bar{H}^{-1})^{-1} = \bar{H} \quad and \quad \bar{H} + \bar{H}^{-1} = 1 \tag{64}$$

1.10. Taking the Evolutionpotential as a characteristic polynomial of a linear map

We can write the Evolutionpotential EP (1) by factorization as characteristical polynomial.
For simplification we set the speed of light c=1 then

$$V(\phi) = -(\frac{\Lambda}{8\pi G})^2 . \frac{1}{\varphi^3+1} .(|\phi|^2 - 0^2).(|\phi|^2 - 1^2).(|\phi|^2 - \sqrt{\varphi}^2).(|\phi|^2 + \varphi^2) \quad (65)$$

$|\phi| = 0 \; and \; |\phi| = 1 \; and \; |\phi| = \sqrt{\varphi}$ are the zeropoints.

To see the connection to a linear map we write it as determinant

$$V(\phi) = -(\frac{\Lambda}{8\pi G})^2 . \frac{1}{\varphi^3+1} . \begin{vmatrix} |\phi|^2 - 0^2 & 0 & 0 & 0 \\ 0 & |\phi|^2 - 1^2 & 0 & 0 \\ 0 & 0 & |\phi|^2 - \sqrt{\varphi}^2 & 0 \\ 0 & 0 & 0 & |\phi|^2 + \varphi^2 \end{vmatrix} \quad (66)$$

then

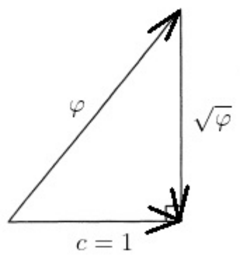
$$V(\phi) = -(\frac{\Lambda}{8\pi G})^2 . \frac{1}{\varphi^3+1} . det(|\phi|^2 . I - M) \quad (67)$$

with I is the unit matrices and M is the matrices for the linear map.

$$M = \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \varphi & 0 \\ 0 & 0 & 0 & -\varphi^2 \end{pmatrix} \quad (68)$$

M is traceless and the eigenvalues of M are $0, 1, \varphi, -\varphi^2$ which are squared speeds.
For the eigenvalues $0, 1, \varphi$ we have real speeds $0, 1, \sqrt{\varphi}$ and for the eigenvalue $-\varphi^2$ we have a imaginaery speed $i\varphi$.
So the speed of light c= 1 appears naturally as the root of an eigenvalue.
Furthermore by the trace of M we get

$$1^2 + \sqrt{\varphi}^2 - \varphi^2 = 0 \Leftrightarrow 1^2 + \sqrt{\varphi}^2 = \varphi^2 \quad (69)$$



This picture shows the speed of light as a geometrical result of other speeds
(squareroot of the eigenvalues of M). This triangle in picture (69) is the so called Kepler triangle.
But the physical appearance of the other real speed $\sqrt{\varphi}$ is actually unknown.

1.11. How i found the Evolutionpotential

I am not able to describe all the inspirations which leads to the formular.Therefore i have to write a complete book.But i found it relative fast and it showed a lot of good properties which encouraged me to keep going.First i find an orientation on the Higgspotential which is of dimension GeV^4 and therefore uses the ϕ^4 theory.The Evolutionpotential is of dimension GeV^8 and therefore uses consequentely the ϕ^8 theory.
For some reasons i had to expanded the field behind it to Octonions $exact\ to\ \mathbb{O}^5 \times\ i\mathbb{R}^8$.
It is clear that massdensity and pressure must be a part of the formular to describe the Λ cosmos but i found out that an additional term is possible.
And what theoretical is possible is often possible in nature.
Someone want ask me why do we have the golden mean in the formular.There is a simple reason which leads to the unique coefficients p, ϱ, σ.
The important behavior of the potential on the interval $[0, c\sqrt{\varphi}]$ is that it is stable.
This means the skewness is zero and only this coefficients leads to this property.

$$\int_0^{c\sqrt{\varphi}} V(\phi)\phi^3 d\phi = 0 \tag{70}$$

2. Conclusion

I showed that the Evolutionpotential for the universe can give answers to some unresolved questions like:

why do we have an expanding universe?
what is dark matter?
why is the cosmological constant so small?
from where comes the weinberg angle?
some connections of quantum physics and general relativity.

So in total there are a lot of good hints that the equation (1) is a real existing potential in nature.
For some of the above questions i only gave just a hint and for some an exact answer.
One question remains open here.Why do we have the definition range with 48 degrees of freedom?
For that i used the doubling process and started with the higgsfield.
An more detailed explanation for that can be found on my homepage https://standardmodell.at

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