COSMOS

An Analytical Model Based on Observations

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Our search for the origin of gravitation and time leads to an analytical model of the evolution of the universe. The model is a mathematical equation based on observations and current physical understanding. It describes the observed cosmic fire as a continuous process of a nuclear reaction. This fire is a source of gravitation and time. It shows an acceleration of the expansion speed of the universe and of the production of dark mass/energy. It starts with the action of Planck's Quantum and with Hubble's Law and describes the earliest moment of our universe. This moment is shared with the Big Bang and originates the graviton with a spin of two and an entanglement of two of Planck's quanta of action.

Comments

16 pages, including 3 figures. It is our aim to present this model in a way that is understandable in broad principle by everyone [1].

The most noticeable cosmic events of the current physical reality (solar energy, gravity, time and periodic changes) are combined mathematically and presented with intuitive notation as a basic analytical model of the cosmic evolution. The model is sufficiently precise to allow a good understanding of the universe as it evolved.

Since it is possible to describe the same process with multiple analytical models, our model should be understood as an addition to other cosmic models.

Materials and Methods

As mathematical and graphical tool for calculation and presentation, a spreadsheet of Excel Software, a product of Microsoft Corporation, is used.

Einstein's energy equation ($\boldsymbol{E = m{*}c^2}$) is applied together with our own observations of the visible universe to the development of the model, an equation of the cosmic expansion speed $\boldsymbol{v}$. Determined by trial and error (T&E) are the model's numerical values of its age $\boldsymbol{T}$ and of its Universal Gravitational Constant $\boldsymbol{G_{CAM}}$, such that they calculate the published Planck Constant $\boldsymbol{h}$. The existence and properties of the graviton $\boldsymbol{g_o}$ are obtained from the model's connection with the Big Bang **BB**.

Einstein's Energy Equation $E = m*c^2$

All physical relations are ultimately based on observations of physical realities. Usually, they are easily understandable and believable. Examples are Hubble's Law [2] and the relation that force is the acceleration of a mass. But not all relations combine their contributing physical realities into something that is easily believable.

Unfortunately, the most famous relation, Einstein's "$E = m*c^2$", is perhaps the most mysterious. While its statement is easily understandable, it is not immediately clear why it is true.

Therefore, before we use it in this paper, we need to demonstrate, that this equation can be based on observations:

Our notation: E = energy; F = force; x = distance; m, m_x = masses; v = speed; t, t_x = times; c = vacuum speed of light.

$$E = \int F*dx$$
$$= \int [d(m*v)/dt]*dx$$
$$= \int v*d(m*v)$$
$$= v^2*m - \int m*v*dv \quad \text{(partial integration)}$$

We substitute:

v	$= c*sinx$	with $0 \le x < \pi/2$
v^2	$= c^2*sin^2x$	
dv	$= c*cosx*dx$	
$m_x/cosx$	$= m_x*[(1-(v/c)^2)]^{-1/2} = m_x*\gamma$	
	$= m_x*(t/t_x) = m$	
m	$= m_x/cosx$	(mass inflation)

γ is the "**Lorentz Factor**" of time elongation which can be **observed** with the interferometer experiment [3] of Michelson and Morley.

$$= (c^2*sin^2x)*(m_x/cosx) - \int [(m_x/cosx)*(c*sinx)*(c*cosx)]*dx$$
$$= m_x*c^2*[(sin^2x/cosx) - \int sinx*dx]$$
$$= m_x*c^2*(sin^2x/cosx + cosx)$$
$$= m_x*c^2*(sin^2x+cos^2x)/cosx = m_x*c^2/cosx = m*c^2.$$

The above calculation shows that the Lorentz Factor not just elongates time, but also inflates mass, i.e. $\gamma = t/t_x = m/m_x$. Thus, we have derived the equation $E = m*c^2$ with the observation of the Lorentz Factor.

Introduction

In the following, we deviate from Einstein's notation: the letter "m" will denote a distance unit of one Meter, while a suffix attached to the letter "m" (such as m_x, m_k, m_h, etc) will denote a mass.

The four cosmic events that have a constant influence on our lives are gravitation, time, sunshine and periodic changes. How do they originate and by which processes? How do they correlate?
From **Hubble's Law** we know that the universe expands with acceleration [4] as was observed in 1998. Hubble's Parameter "H" for galaxies that move away from us:

$$v=H*x \quad (v\text{=speed}) \quad (1)$$
$$dv/dt=H*dx/dt \quad (x\text{=distance}) \quad (2)$$
$$g=H*v \quad (g\text{=cosmic gravity}) \quad (3)$$
$$H=g/v=1/t \quad (t\text{=cosmic age}) \quad (4)$$

This indicates that H depends on t, i.e. $H=H(t)$, although for a given time t, $H(t)$ is uniformly distributed through space. We define $H(T)=H_o$. This is the "Hubble Constant". Please note that by (4), $H_o*T=1$, (5) if we adjust T for time elongation.

We accept Einstein's equivalence principle (gravity is acceleration) as valid.

The acceleration g of galactic masses requires force and energy. Where does it come from? The answer can be seen by day and night with the bare eyes.

The Fire

By looking at the sun or observing the nightly sky, one must realize that almost the entire visible universe is on fire. The sun and every star and visible galaxy are spots in the universe, where mass is involved in a nuclear fusing process spreading light and other radiation into all directions.

This is a statistical process, **The Fire**. It is a continuous [6] **exo**thermic process producing heavier mass m_g from lighter mass and radiating energy with a mass equivalent m_h. Heavier mass may be fused again by an **endo**thermic process absorbing an energy equivalent of a mass m_h. This process occurs in black holes, as may be observable with telescopes [7].

m_g and m_h are accumulated over time. We denote:
m_o : total cosmic mass
$m_f=m_g+m_h$: fused cosmic mass
m_g and m_h relate to each other at a time t as shown below:

$E(m_f)$	$= E(m_g)$	$+ E(m_h)$	(burnt mass energy)	(5.1)
m_f*c^2	$= m_g*c^2$	$+ m_h*c^2$	(Einstein's energy equation)	(5.2)
m_f*c	$= m_g*c$	$+ m_h*c$	(momentum)	(5.3)
$(m_f/m_o)*c$	$= (m_g/m_o)*c$	$+ (m_h/m_o)*c$	(speed-mass relation)	(5.4)
v_f	$= v_g$	$+ v_h$	(speed relation)	(5.5)
v_g	$= (m_g/m_o)*c$		(speed-mass relation 1)	(5.6)
v_h	$= (m_h/m_o)*c$		(speed-mass relation 2)	(5.7)

Please note that v_g and v_h are less than c.

Time Dependency of The Fire

To describe the timely progress of **The Fire** in simple terms, we ignore, like Hubble's Law, any spatial anisotropy and state its macro structure: as with any open fire, the timely rate of increase of the burnt mass is proportional to the mass not yet burnt. This is a statistical relation, a burning pattern that applies to the masses m_o, $m_g(t)$ and $m_h(t)$:

$dm_g(t)/dt$	$= k_g*(m_o - m_g(t))$	(constant $k_g > o$)	(6.1)
$dm_h(t)/dt$	$= k_h*(m_o - m_h(t))$	(constant $k_h > o$).	(6.2)
$d(m_o - m_g(t))/dt$	$= - k_g*(m_o - m_g(t))$	this follows	(6.3)
$d(m_o - m_h(t))/dt$	$= - k_h*(m_o - m_h(t))$	with $dm_o/dt = o$.	(6.4)
$d(m_o - m_g(t))/(m_o - m_g(t))$	$= - k_g*dt$	modified for	(6.5)
$d(m_o - m_h(t))/(m_o - m_h(t))$	$= - k_h*dt$	integration.	(6.6)
$Ln(m_o - m_g(t))$	$= - k_g*t$	integral	(6.7)
$Ln(m_o - m_h(t))$	$= - k_h*t$	integral.	(6.8)

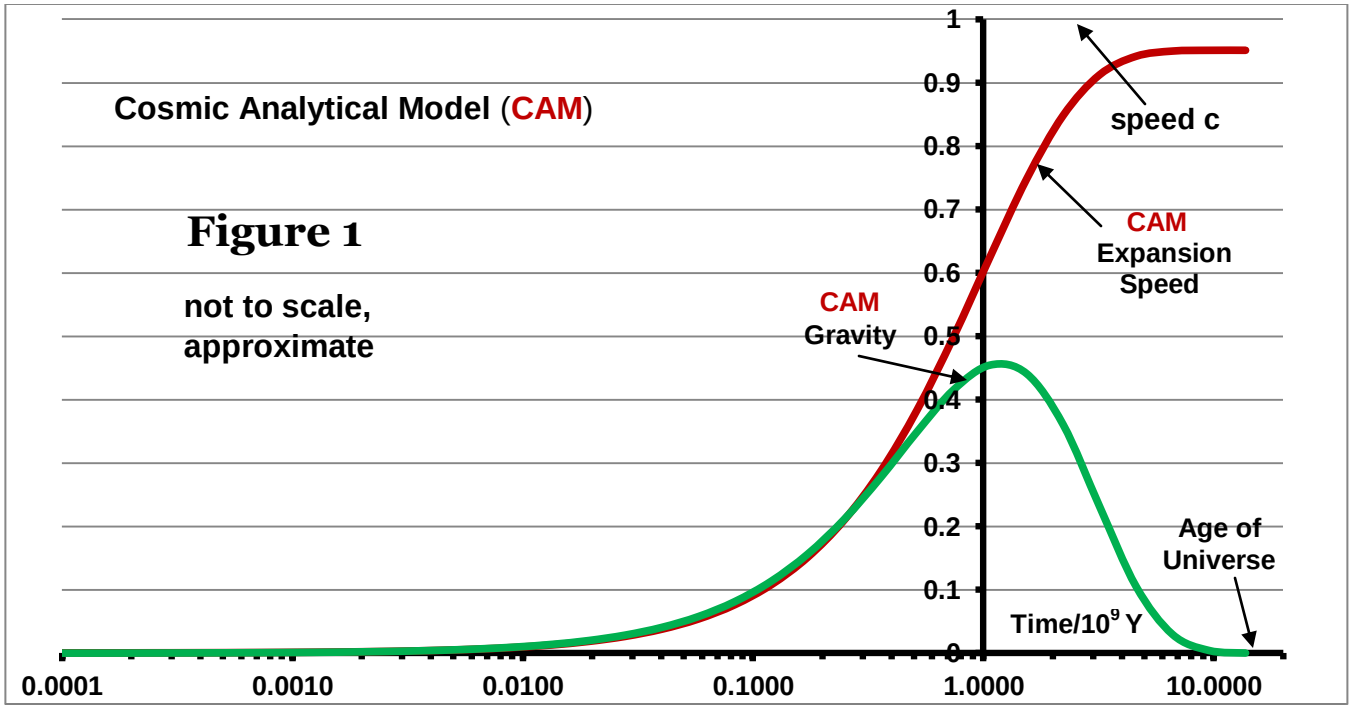
The quotient $Ln(m_o - m_g(t))/Ln(m_o - m_h(t)) = k_g*t/k_h*t = k_g/k_h$ converges to 1 for $t \rightarrow o$. Therefore, $k_g = k_h = k$ as k_g and k_h are constants.
The beginning boundaries of the integrals (6.7) and (6.8) may not be identical: We can select $t = o$ for m_g and $t = t_o > o$ for m_h. As the beginning times for both masses, m_g and m_h, differ, we set the boundaries $o \rightarrow t$ and $t_o \rightarrow t$ for m_g and m_h (respectively). We obtain for m_g:

$Ln(m_o - m_g(t)) - Ln(m_o - m_g(o))$	$= -k*t,$	and since $m_g(o) = o$:	(7.1)
$Ln[(m_o - m_g(t))/m_o]$	$= -k*t,$	or	(7.2)
$(m_o - m_g(t))$	$= m_o*e^{-k*t},$	or	(7.3)
$m_g(t)/m_o$	$= 1- e^{-k*t}.$	with (5.6) it follows:	(7.4)
$v_g(t)$	$= c*(1 - e^{-k*t}),$	and likewise for m_h:	(7.5)
$v_h(t)$	$= c*(1 - e^{-k*(t-t_o)}).$		(7.6)

We define $m_d^2 = m_g*m_h$ and $v^2 = v_g*v_h$ and obtain with equations (5.6 and 5.7):

$(m_d/m_o)^2 = (m_g/m_o)*(m_h/m_o) = (v_g/c)*(v_h/c) = (v/c)^2$, hence $m_d/m_o = v/c$ (7.7)
and
$v(t) = c*[(1 - e^{-k*t})*(1 - e^{-k*(t-t_o)})]^{1/2}$; $D_{me} = v(T)/c$ (% dark mass/energy) (8)

This is the **C**osmic **A**nalytical **M**odel Equation **(CAM).**



The purpose of this graph is to illustrate the **CAM** and its **gravity** (***g*=*dv*/*dt***). For illustration, **Figure 1** is not to scale. In particular, the time ***t*** is on a logarithmic scale. t_o is the beginning time of the **CAM** (in this graph $0.0001*10^9$ or ***100,000*** **Y**ears). Numerical values of ***g*** are adjusted for printed visibility. It can be seen that the **CAM** ***v*** and its **gravity** ***g*** are very low near the time t_o and that the current expansion speed ***v*** is about 95% of the speed of light ***c*** while the gravity ***g*** is nearly zero.

The question arises "Does the **CAM** describe reality?". It is a question that cannot be answered at this point. The model is developed from observations rather than from a theory. It should earn its credibility by presenting the physical reality at the very early cosmic beginning. It should lead to the numerical value of Planck's quantum of action "***h***" and to the existence of the graviton "g_o".

For simplicity, numerical results are calculated in **CAM**'s "cosmic" units such as distance and time of one light year (***L***) and one year (***Y***) respectively. Thus, the speed of light ***c*** has the value ***1L/Y*** and t_o is small relative to the age ***T*** of the universe . For comparison, calculated values may be re-converted into the traditional international system or "**SI**" units, such as meter (***m***), seconds (***s***) and Joule (***J***). The **SI** unit "kilogram" (***kg***) is used unchanged in the **CAM**.

The calculations are executed in a Microsoft Spreadsheet ("Excel"), a product of the Microsoft Corporation. All spreadsheet cells reference other cells except for the published value of Planck's Constant ***h*** and six values of the cosmic age ***T*** around its probable actual value. For each selected value of ***T***, the gravity ***G*** is then determined by T&E from the value of ***h***. The ***T*** - ***G*** pairs are then further processed, see "**Variations of *T* and *G***".

Pages 13 - 15 of this paper present the spreadsheets with the heading "**SUMMARY SHEET (A)**" and "**SUMMARY SHEET (B)**" and the data for **Figures 1** and **3** with the heading "**DATA SHEET**". SUMMARY SHEET (A) is a picture of the spreadsheet's user interface while SUMMARY SHEET (B) lists all cell references to allow re-constructing of the SUMMARY SHEET (A) .

Properties of the CAM

1. The **CAM** is not valid for cosmic times $t < t_o$. For these times, the value in the brackets ($[\ ]$) of equation (8) is negative, and the real square root does not exist. The **CAM**'s domain of t is $[t_o \le t \le T]$. $v(t_o) = 0$, and by equation(8) $v(T) = c*D_{me}$ are the lower and upper bounds of $v(t)$. t_o is the time unit of the **CAM**, and $g(t_o) = v(t_o)/t_o = 0$.

2. As k has the unit of 1/time, both exponents, $k*t$ and $k*(t-t_o)$ of the **CAM** equation, are invariant with any change of the time unit. Therefore, we can use any convenient time unit with calculations involving the **CAM**, such as years or seconds, or even a small indivisible time interval, and we can assign to t_o an actual time of our choice: we select $t_o = 1\ Y$, while retaining the freedom to change this.

3. Since v^2, defined as v_g*v_h, is a scalar by the **CAM**, v_g and v_h have identical directions.

4. For large values of the time t the **CAM** approximates (≈) to

$$v(t) \approx c*(1-e^{-k*t}) \quad \text{and} \quad k*t \approx Ln(1/(1-v/c)). \qquad (9.1)$$

With $v(T) = T*G(T)$ by Hubble, equation(4), we obtain:

$$k*T \approx Ln(1/(1-T*G/c)). \qquad (9.2)$$

Thus, if we know the values of T and G, we can calculate the value of $k*T$ and k.

5. The unit of k (1/time) hints that it is the Hubble Parameter H [8]. As we observe galactic recession speeds with cosmic time backwards, Hubble's Law can be approximated (≈) by the **CAM**:

$$g=-H*v \quad \text{by equation (3)}$$
$$k*e^{-k*t} \approx -H*(1-e^{-k*t}) \quad 1^{st} \text{ derivative}$$
$$-k^2*e^{-k*t}=-H*k*e^{-k*t} \quad 2^{nd} \text{ derivative}$$
$$k = H \quad \text{equation (10)}$$

Thus, k depends, like H, on time, i.e. $k(t)=H(t)=1/t$. This implies that the distance t of a celestial object, observed in units of light years, must be adjusted for time elongation, and

$$v(T) = g(T)/k(T) = g(T)/H_o . \qquad (11)$$

About the Fire

The **CAM** is a cosmic macro structure of an exothermic fire, **The Fire,** by equations 5.1-5.7 and 8, but it does not reveal the ultimate source of the energy igniting the fire. This can only be the **BB's** energy h/t_o [9]. As this energy is larger than zero, there should exist some non-zero time t and gravity g such that

$$0 < E(t_o)=h/t_o=m_k*(g*t)^2. \quad [9] \qquad (12)$$

The Planck Constant

Equation (12) shows that the **BB** is the origin of time and gravity. It also shows a possibility of approximating the numerical value of h by modifying the relation(12) algebraically at $t=2t_o$:

$$h \approx m_k * v_p * v_x * t_o = p * x, \qquad (13)$$

where v_p and v_x are two minimal speeds of the **CAM** at $t=2t_o$:

We calculate the numerical value of h:

$$v_p = t_o * g_p = v(2t_o)/2 \qquad (14.1)$$
$$= c*[(1-e^{-k*2to})*(1-e^{-k*(2to-to)})]^{1/2}/2$$

and

$$v_x = t_o * g_x = t_o * (G-g_p) * (t_o/T). \qquad (14.2)$$

v_p is the minimum positive speed of the **CAM**. v_x is the average increase of the **CAM**'s expansion speed during the time interval t_o, averaged over the entire time T of the **CAM**.

The exponent k of v_p is calculated per equation(9.2) with the published numerical values of T and G. v_x is calculated with $g_p=v_p/t_o$ and with the published numerical values of T and G.

As expected, the numerical value of h, calculated per equation(13), is close but not equal to the published numerical value of h. Therefore, we conclude that the **CAM** possesses its own specific numerical values of T and G. They can be determined.

Here is how:

Variations of T and G

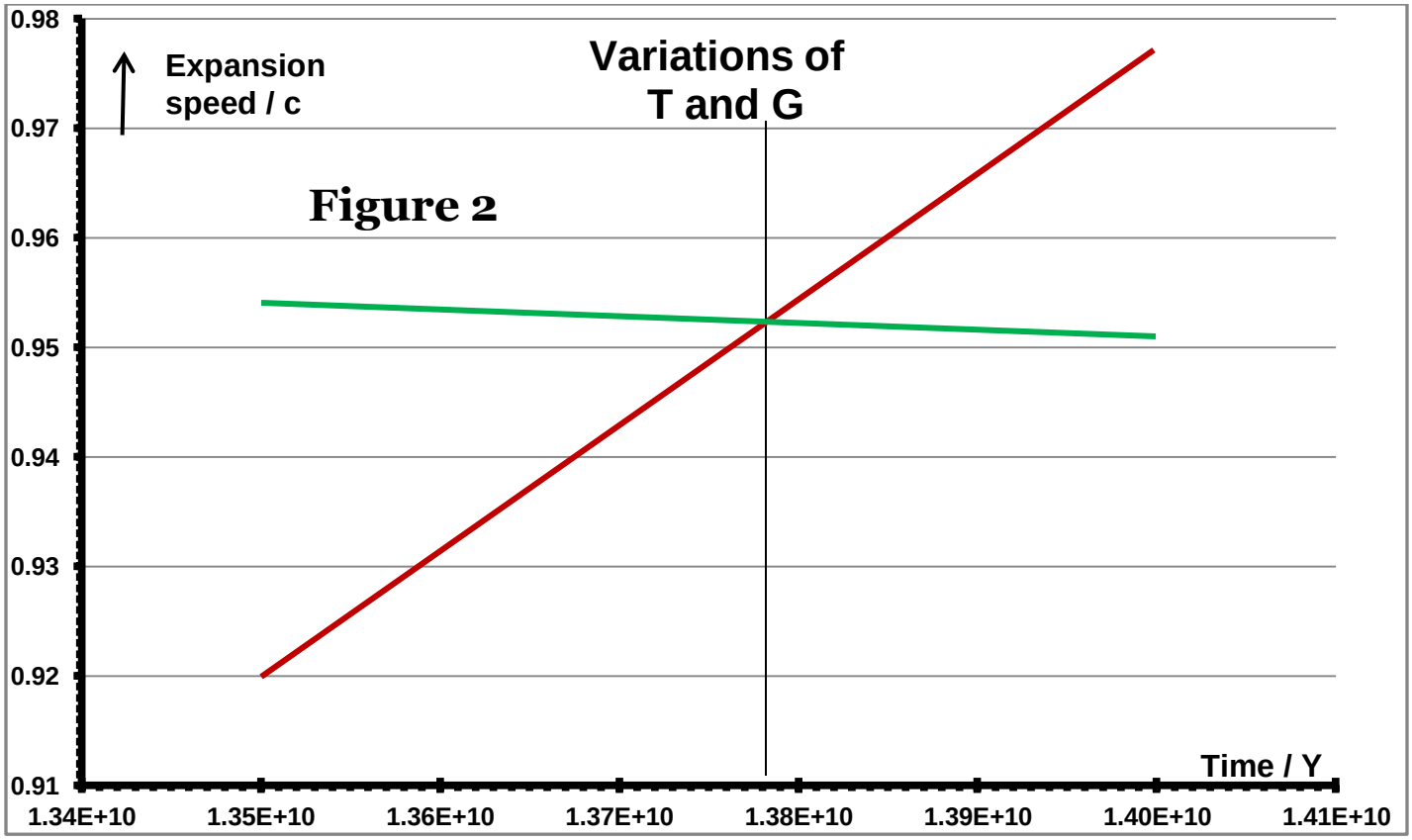
For each "time slice" T_i, starting at $T_1 = 13.5*10^9\ Y$ and incrementing by 10^8 years until $T_6 = 14.0*10^9\ Y$, the following is tabulated, see **Figure 2**:

1. T_i, G_i, and k_i.
G_i is obtained by T&E such that the equation (13) is true, i.e.
$h/t_o = m_k * v_{pi} * v_{xi}$. v_{pi} and v_{xi} are calculated by equations (14.1-2) with k_i as per equation (9.2).

2. $v_i = T_i * G_i/(k_i * T_i)$ (15)
by **Hubble**, v and G are proportional. v_i decreases with increasing i.

3. $v_i = T_i * G_i/D_{mei} = T_i * G_i/(v_i/c)$ (16)
by **CAM**, equation (8). Algebraically,
$v_i^2 = v_i * v_i = c * T_i * G_i$
$= (h/t_o)/m_k$
by equation (12), if we adapt the **CAM** units of G_i to the **SI** units of h/t_o, i.e. we multiply G_i by 9.500052611.
We obtain
$v_i = c * 9.500052611 * T_i * G_i/v_i$.
v_i increases with increasing i, see **SUMMARY SHEET**s.
The graphs of v_i and v_i, which are expansion speeds of different models, **Hubble** and **CAM**, are shown in **Figure 2**.

Physical reality can exist only at the intersection point, where
$v = v$ and $v/v = 1$.
Per **Figure 2**, the age T at $v = v$ is $T \approx 13.78*10^9 Y$. Starting with this value, a T&E search to obtain precise values for T and G_{CAM} is possible in multiple steps that show v/v converging to 1. G_{CAM} is determined in the same way as G_i above (in **1.**), see bottom of **SUMMARY SHEET(A)**.



graphs (Ti,vi(Ti))	Ti (time slice)	Gi (T&E)	ki*Ti = -Ln(1-Gi*Ti/c)	vi = Gi*Ti/(ki*Ti)	vi = c*9.500052611*Gi*Ti/vi
Inputs of Ti	13500000000	6.834699904E-12	0.096806592	0.953121542	0.919667721
resulting in Gi,	13600000000	6.863755926E-12	0.097995571	0.952564282	0.930963079
and published	13700000000	6.892743094E-12	0.099191340	0.952004280	0.942322950
value of h,	13800000000	6.921751844E-12	0.100395280	0.951440899	0.953760442
vi and vi, see	13900000000	6.950705858E-12	0.101606251	0.950874679	0.965264731
Variations of T & G	14000000000	6.979644309E-12	0.102824867	0.950305343	0.976841645

Our values for T, G_{CAM} and v are:

$T = 13{,}780{,}742{,}831\ Y$

$G_{CAM} = 6.916149399*10^{-12}\ L/Y^2$

$= 6.570378316*10^{-11}\ m/s^2$

$v = 0.951549756\ c.$

The above **SI** value of G_{CAM}, the cosmic gravity, is less than the Internet-published **SI** value of the universal gravitational constant, $G=6.6743*10^{-11}\ m/s^2$, i.e. less by $G_\Delta=0.1039*10^{-11}\ m/s^2$. This missing gravity is therefore not a product of the **CAM**. It must come from the **BIG BANG**.

CMBR and Gravity

(**C**osmic **M**icrowave **B**ackground **R**adiation). It is a "dark" energy radiation originated by the **BB**. Its energy density is with Hubble's Law ($v = k*x$):

$$E_\Delta/V = m_k*G_\Delta*x/x^3 \qquad V=x^3=\text{space},$$
$$=m_k*G_\Delta/[v/k]^2 \qquad V\text{olume}$$
$$=m_k*G_\Delta/[(2T*v)/(2k*T)]^2$$
$$=m_k*G_\Delta*(2k*T)^2/(2T*v)^2. \quad (17)$$

The published numerical value of E_Δ/V [10] ($=4.17*10^{-14}$) is calculated by $m_k*G_\Delta*(2k*T)^2$, see **SUMMARY SHEET**s. This implies that

$(2T*v)^2=1L^2=(t_o*c)^2$ and $(v*T)/t_o=c/2$. Therefore, the **BB** has produced a universe at the time t_o with an expansion speed $c/2$, a "mass-less" gravity $(c/2)/t_o$ [11] and the factor (Hubble Constant) $k=1/t_o$. t_o is the border between the **BB** and the **CAM**. The **BB** expansion speed and gravity are at their maximum, because they are proportional by equation (4), and $g=(c/2)/t$ is decreasing for increasing $t>t_o$. equation (17.1)

The Cosmic Time Elongation

The Hubble Constant at time t_o is $k = 1/t_o$, therefore, $k*t_o=1$. However, $k*T=0.10016257754$. Thus, $k*t$ **de**creases as t **in**creases. This is true because we observe time from T to t_o, i.e. backwards. The time t becomes "elongated" by the factor $1/k*t$:

$t = t/k*t_o \le t/k*t$. Our factor is $1/k*T=9.983768635$.

The **BB** gravity $(L/2)/t^2$ quickly becomes negligible. Currently it is about $2.5*10^{-20}\ m/s^2$. But original measurable **BB** gravity still exists today because of the time elongation, $(k*t)^{-1} \approx (1-t*0.9/T)^{-1}$, as calculated with $k*t_o=1$ and $k*T\approx0.1$. Therefore,

$v(t)/t=v(t)/(t/kt)$
$\approx(v(t)/t)*(1-t*0.9/T)$
$\approx (c/2)/t$ for small t
$\approx 0.1*(c/2)/t$ for large t.

Also,
$v(t)/t=(E(t)/m_k)^{1/2}/(t/kt)\approx(c/2)/t$
if $E(t)=m_k*(c/2)^2$ and t is small.
Thus, $v(t)/t$ is nearly constant while t is small and $E(t)$ is constant.

At the time $t_{RC}\ (=3.8*10^5 Y)$, when the **Fire** started [12], the **BB** has left behind a gravity G_{RC} and an energy density E_{RC}. Both contribute to the beginning of the **Fire**.

Ignition of The Fire

There is no exact time for a sudden ignition of **The Fire**. Per **CAM**, the ignition is still going on today.
For the time t_{RC}, the gravity is
$G_{RC}=9.5*((c/2)/t_{RC}/k*(T-t_{RC}))$
$=1.2520046*10^{-6}\ m/s^2$.
The expansion speed, obtained by linear interpolation from the **DATA SHEET**, is
$v(t_{RC})=4.5257846*10^{-4}\ L/Y$. Thus,
$E_{RC}=m_k*G_{RC}*x/x^3$
$=m_k*v^2/(v*t)^3$
$\approx m_k/[v*(t_o*k*(T-t_{RC}))^3]$
$=m_k*2.1990017*10^6\ kg*J/m^3$.
This energy density is similar to achievements of current (December 2023) developments of controlled hydrogen fusion, [13]
see **SUMMARY SHEET**s.
The gravity, which is about half a million times of our current one, must have caused instances of gravitational collapse and ignition of Hydrogen clouds [14]. The figures of G_{RC} and E_{RC} may indicate that the ignition of self sustaining hydrogen fusion requires two components, G_{RC} and E_{RC}.

The Dark Mass/Energy

Per **SUMMARY SHEET (A)** and by equations (7.7 and 8), the burnt part of the total cosmic mass m_o at time T is $D_{me}=v(T)/c=95.1549756\%$. [15]
What does it consist of? It is the "ash" and released energy of **The Fire**. We can reasonably assume that the ash is located in the vicinity of **The Fire** that has created it, mostly near the center of galaxies. And that is where

this dark mass has been noticed. In the case of our own galaxy, the Milky Way, this "ash" consists of the heavy fused elements. These fused elements range from Helium through Uranium and are mixed with Hydrogen. Compared to a star, they radiate very little and hardly with visible light, but they interact with it.
A fine sample of dark mass is our own planet, the earth. An example of its interaction with electromagnetic waves is photosynthesis, the basis of all plant life and ultimately our own. It is also baryonic as it consists of atoms. Its distribution throughout the universe must be far from being uniform. Intergalactic space should be essentially clear of dark mass. Thus it was possible that the Hubble Telescope could have an "ultra deep space" view penetrating 13 billion light years into space. But it can never see the very center of our own Milky Way, which is hidden by a Black Hole. The question arises "what is dark energy?" [16]. It is the energy-equivalent of the mass-deficit that has occurred and continues to occur by the cosmic nuclear fire. The following shows this: The portion of the heavy fused mass of **The Fire** is according to its energy and definition $x=(T/t_o)*L$ (distance):

$$[(m_k*(G-g_p)*x)/(m_k*G*x)]/D_{me} = (G-g_p)/(G*D_{me}).$$

Therefore,

$$D_{me} - (G-g_p)/(G*D_{me})=.681579998$$

is the radiation portion of the dark mass/energy, see **SUMMARY SHEET**s.

The Graviton

Relation (12), $h/t_o \approx m_k*v^2$, is altered algebraically to fit the **BB**:

$$t_o*g = (m_k*(t_o*g)*t_o)^{-1}*h. \qquad (18)$$

At the border t_o between the **BB** and **CAM**, t_o*g is at its maximum $c/2$, see equation (17.1) and **DATA SHEET**. Thus, t_o*g is at a cosmic minimum, t_o*g_o, and therefore not divisible. By replacing t_o*g with $c/2$, we obtain:

$$t_o*g_o = (m_k*(c/2)*t_o)^{-1}*h = 2*h/(m_k*c*t_o). \qquad (19)$$

Equation (19) has physical reality as m_k, c and t_o have a numerical value of one. g_o is not a product of the **CAM**'s **Fire** as it emerges at t_o, nor is it divisible by any number but 1. Therefore, g_o, a remain of the **Big Bang**, is the cosmic minimum of acceleration. It is numerically equal to $2*h$, entangles two of Planck's quanta of h and has no mass, because m_k cancels out of the right side of equation (19). But g_o has a "**SPIN**". By equation (19):

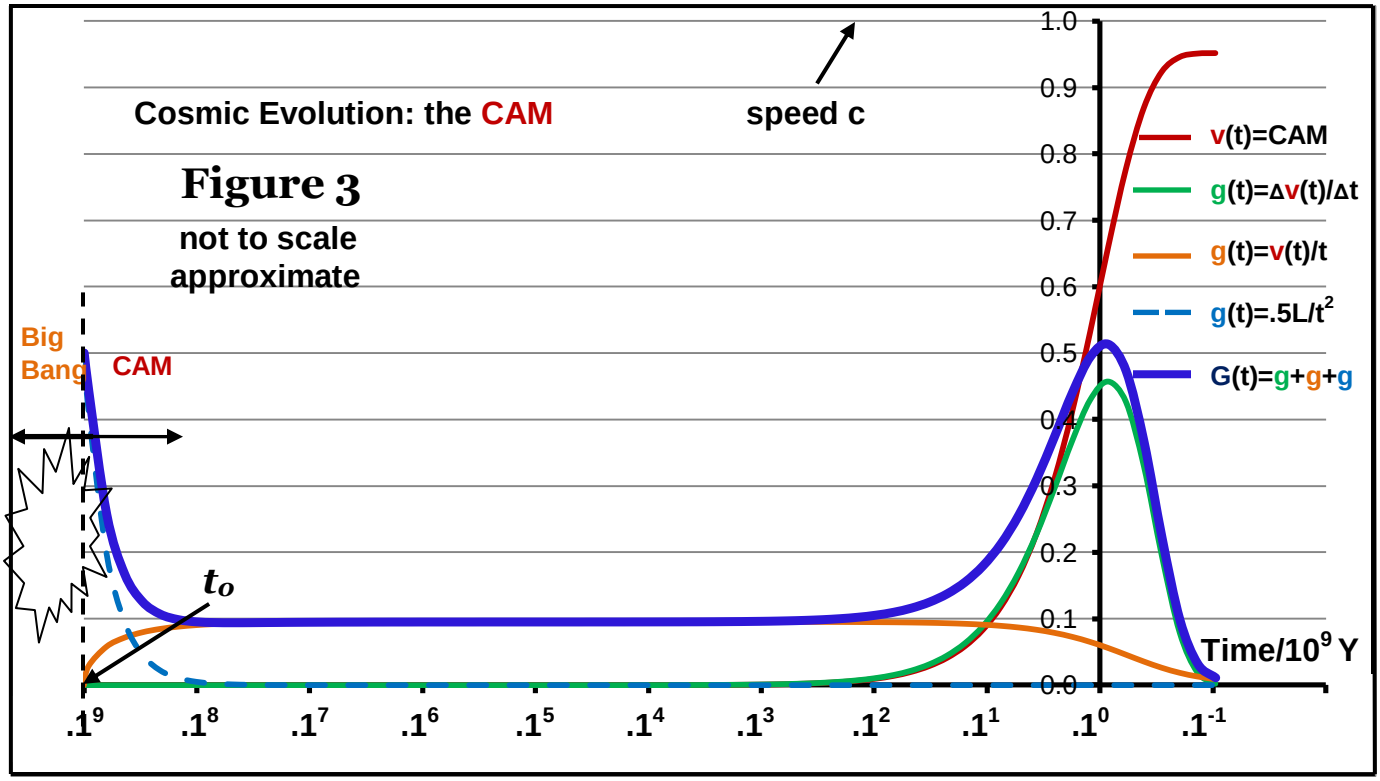
$$m_k*t_o*g_o*c*t_o/(2\pi)=2*h/(2\pi)=2*\hbar.$$

t_o*g_o is a speed and $c*t_o/2\pi$ is a distance (radius) from the t_o*g_o axis. Since the **SPIN** is measured in units of $\hbar$, the **SPIN** of g_o is 2. We calculate:

$$g_o = (2*h/t_o)/(m_k*c*t_o) \qquad L/Y^2,$$
$$= 1.25896030*10^{-32} \qquad m/s^2.$$

g_o is the graviton, the smallest quantum of gravity, emerging from the **BB** at its maximum speed $c/2$. Thus, the graviton g_o exists. It may be observable and measurable [17], has a **SPIN** of 2 but no mass and entangles two of Planck's quanta h.

Figure 3 (not to scale!) shows to the left the very early time of the **CAM** universe. It shows the big increase of its gravity at $3.8*10^5$ years. This is the time when after the **BB** the formation of the first stars began.



But is the **CAM** correct?
As a partial cosmic model, it is correct. It is partial, because it excludes the **BB**. However, current gravitational measurements contain **BB** impact even today. Thus, current cosmic reality includes the fossil remains of the **BB**. Combining the **BB** gravity with that of the **CAM** results in a complete model of the universe.

Also, the **CAM** is a statistical model, producing statistical results. The numerical value of T, and with it of the Hubble Constant $1/T$, has a statistical distribution dependent on the precision of h and other factors. Thus, Hubble's Constants determined from different selections of cosmic objects may not be the same.

So far, we know about the **CAM**:

- The **CAM**'s constant is $k = H$.
- The **CAM** relates the Planck constant h, the age of Universe T, the universal expansion acceleration G_{CAM}, the speed of light c, and the percent of dark mass/energy D_{me} to each other.
- The **CAM** is invariant to the cosmic time elongation.
- The **CAM** identifies the origin, composition, location and distribution of dark mass/energy.
- The **CAM**'s plus **BB**'s gravity is equal to the current gravity G.
- The **CAM**'s border with the **BB** originates the graviton.
- The **CAM** bases its gravity and time on the Planck Constant h.

Calculations (see **SUMMARY SHEET**s)

Age of the universe	***: T***	***= 13,780,742,831 Y***
k value	***: k***	***= 7.268300321*10^{-12} Y^{-1}***
Hubble Constant	***: H_o***	***= 70.955035954 km/s/Mpc***
CAM's Cosmic Gravity	***: G_{CAM}***	***= 6.570378316*10^{-11} m/s^2***
Published Cosmic Gravity	***: G***	***= 6.6743*10^{-11} m/s^2***
Current Big Bang Gravity	***: G_Δ***	***= 0.1039*10^{-11}m/s^2***
Graviton	***: g_o***	***= 1.25896030*10^{-32} m/s^2***
Percent dark mass/energy	***: D_{me}***	***= 95.1549756 %***
Percent dark energy	***:***	***= 68.1579998 %***
CAM's Cosmic expansion speed	***: v***	***= 0.951549756 c***
CMBR Energy Density	***: E_Δ/V***	***= 4.17*10^{-14} J/m^3***

This paper was possible by using the extensive computing power and graphical ability of desk top computers. They are tools for solving equations by T&E within their limitation to any desired precision, which cannot be solved algebraically. They also can display comprehensive illustrations of cosmic interactions and have available for immediate access an immense volume of Internet information. Neither existed 60 years ago as a tool for scientific research.

Conclusion

The large-scale cosmic fire described by the **CAM** is not only the essential current source of gravitation and time, but also connects at its beginning by its micro cosmos to the **BB**. The connection of the small-scale micro cosmos to the **BB** leads to the existence and properties of the graviton. The large scale **CAM** model, with its unifying and elegant structure, shows not only the accelerated expansion of the universe, but sends above all the powerful message that the creation and evolution of this precious world continues.

Hans W Arnold

1	A	B	C	D	E	F
2				**SUMMARY SHEET (A)**		
3						
4		Notation	Constants	CAM Equation	Hubble Constant	c = Light year/Year
5				$v(t) = c*[(1-e^{-kt})*(1-e^{-k(t-t0)})]^{1/2}$	$k = H_0$	$c = L/Y = 1$
6						
7		SI G_{CAM}	6.570378316E-11	calculated	cosmic gravitation	m/s^2
8		Published G	6.674300000E-11	Internet published	cosmic gravitation	m/s^2
9		G_{CAM}	6.916149399E-12	trial & error	cosmic gravitation G	L/Y^2
10		Input T	13780742831	trial & error	age of cosmos T	Y
11		D_{me}-expansion speed v	0.951549756	calculated	cosmic expansion v	c
12		H_0	70.955035954	calculated	Hubble Constant H_0	Y^{-1}, km/s/Mpc
13		c	1		speed of light c	L/Y
14		t_0	1		CAM time unit t_0	Y
15		m_k	1		mass unit m_k	kg
16		h	6.62607015E-34	Internet published	Planck Constant h	$kg*m^2/s$
17		Dark Energy	0.681579998	calculated	% Dark Energy	%/100
18		g_0	1.25896030E-32	calculated	Graviton	m/s^2
19						
20				k*T calculation	k*T	
21				k*T = Ln(1/(1-G*T/c))	0.10016257754	number
22						
23				k calculation	k	
24				k = k*T/T	7.268300321E-12	Y^{-1}
25						
26				$v(2t_0)$ calculation	$v(2t_0)$	
27				$v(2t_0) = c*[(1-e^{-2kt0})*(1-e^{-k(2t0-t0)})]^{1/2}$	1.027892430E-11	L/Y
28						
29				g_p calculation	g_p , v_p	
30				$g_p = v(2t_0)/2t_0$	5.139462150E-12	L/Y^2
31				$v_p = g_p*t_0 = v(2t_0)/2$	5.139462150E-12	L/Y
32						
33				v_x calculation (average)	v_x	
34				$v_x = g_x*t_0 = t_0*(G-g_p)*(t_0/T)$	1.289253614E-22	L/Y
35					3.865085098E-14	m/s
36						
37				Planck h calculation	h	
38				$h = m_k*v_p*v_x*t_0$	6.62607015E-34	$kg*m^2/s$
39						
40				Graviton calculation		
41				$g_0 = 2h/(m_k*c*t_0)$	1.32521403E-33	L/Y^2
42					1.25896030E-32	m/s^2
43						
44				Dark Mass/Energy calculation		
45				$D_{me} = (G/k)/c$	0.951549756	%/100
46						
47				Dark Energy % calculation		
48				$D_{me} - (G-g_p)/(G*D_{me})$	0.681579998	%/100
49						
50				CMBR Energy Density at T		
51				$m_k*G_\Delta*(2kT)^2/(t_0*c)^2$	4.170394630E-14	$kg*J/m^3$
52						
53				Energy Density E_{RC}		
54				$m_k/[v*(t_0*k*(T-t_{RC}))^3]$	2.1990553E+06	$kg*J/m^3$
55						
56				Recombintation G_{RC}		
57				$9.500052611*(c/2)/(t_{RC}/k*(T-t_{RC}))$	1.2520046E-06	m/s^2
58						
59				Age of Universe		
60	k*T	T (T&E)	G (T&E)	v	v	v/v
61			such that $m_k*v_p*v_x*t_0 = h$	G*T/(k*T)	c*9.50005261095*G*T/v	
	0.100153680	13780000000	6.915938055E-12	0.951553919	0.951465226	1.00009321724
	0.100162406	13780725000	6.916147100E-12	0.951549836	0.951548129	1.00000179481
	0.100162598	13780745000	6.916149680E-12	0.951549747	0.951549954	0.99999978148
	0.100162574	13780742500	6.916149358E-12	0.951549758	0.951549726	1.00000003306
	0.100162577	13780742800	6.916149395E-12	0.951549756	0.951549753	1.00000000314
	0.100162578	13780742830	6.916149398E-12	0.951549756	0.951549756	1.00000000025
	0.100162578	13780742831	6.916149399E-12	0.951549756	0.951549756	1.00000000002
69						
70						
71						

1 A	B	C	D	E	F
2			**SUMMARY SHEET (B)**		
3					
4	Notation	Constants	CAM Equation	Hubble Constant	c = Light year/Year
5			$v(t) = c*[(1-e^{-kt})*(1-e^{-k(t-t0)})]^{1/2}$	$k = H_0$	c = L/Y = 1
6					
7	SI G_{CAM}	=C9*299792458/(3600*24*365.2422)	calculated	CAM cosmic gravity	m/s^2
8	G	=6.6743*10^-11	Internet published	published cosmic gravity	m/s^2
9	G_{CAM}	=C68	trial & error	CAM cosmic gravity	L/Y^2
10	Input T	=B68	trial & error	age of cosmos T	Y
11	D_{me}-expansion speed v	=E45	calculated	cosmic expansion v	c
12	H_0	=(C13/(C10*3600*24*365.2422))*(3.08567758128*(10^19))	calculated	Hubble Constant H_0	Y^{-1}, km/s/Mpc
13	c	=1		speed of light c	L/Y
14	t_0	=1		CAM time unit t_0	Y
15	m_k	=1		mass unit m_k	kg
16	h	=E31*E34	Internet published	Planck Constant h	$kg*m^2/s$
17	Dark Energy	=E48	calculated	% Dark Energy	%/100
18	g_0	=E42	calculated	Graviton	m/s^2
19					
20			k*T calculation	k*T	
21			k*T = Ln(1/(1-G*T/c))	=LN(1/(1-C9*C10/C13))	number
22					
23			k calculation	k	
24			k = k*T/T	=E21/C10	Y^{-1}
25					
26			$v(2t_0)$ calculation	$v(2t_0)$	
27			$v(2t_0) = c*[(1-e^{-2kt0})*(1-e^{-k(2t0-t0)})]^{1/2}$	=C13*((1-EXP(-2*E24))*(1-EXP(-E24)))^0.5	L/Y
28					
29			g_p calculation	g_p , v_p	
30			$g_p = v(2t_0)/2t_0$	=E27/(2*C14)	L/Y^2
31			$v_p = g_p*t_0 = v(2t_0)/2$	=E30*C14	L/Y
32					
33			v_x calculation (average)	v_a	
34			$v_x = g_x*t_0 = t_0*(G-g_p)*(t_0/T)$	=C14*(C9-E30)*(C14/C10)	L/Y
35				=E34*299792458	m/s
36					
37			Planck h/t_0 calculation	h/t_0	
38			$h/t_0 = m_k*v_p*v_x$	=E31*E34	$kg*L^2/Y^2$ (= $kg*m^2/s^2$)
39					
40			Graviton calculation		
41			$g_0 = (2.h/t_0^2)/(m_k.c)$	=2*E38/C14^2	c/Y
42			g_0 . 9.50005261095	=E41*9.50005261095	m/s^2
43					
44			Dark Mass/Energy calculation		
45			$D_{me} = (G/k)/c$	=(C9/E24)/C13	%/100
46					
47			Dark Energy % calculation		
48			$D_{me} - (G-g_0)/(G.D_{me})$	=E45-((C9-E30)/(C9*E45))	%/100
49					
50			CMBR Energy Density at T		
51			$m_k.G_A.(2kT)^2/(t_0.c)^2$	=C15*(C8-C7)*(2*E21)^2/(C14*C13)^2	$kg.J/m^3$
52					
53			Energy Density E_{RC}		
54			$m_k/[v_x.k_x.(T-t_{RC})^3]$	=C15/((4.5257846*10^-4)*(C14*(E24*(C10-3.8*10^5))^3))	$kg.J/m^3$
55					
56			Recombintation G_{RC}		
57			$9.50005261095.(c/2)/(t_{RC}/k_x.(T-t_{RC}))$	=9.5*(C13/2)/(3.8*10^5)/E24*(C10-3.8*10^5)	m/s^2
58					
59			Age of Universe		
60 k_xT	T (T&E)	G (T&E)	v	v	v/v
61		such that $m_k*v_p*v_x*t_0 = h$	G*T/(k*T)	c*9.50005261095*G*T/v	
=LN(1/(1-C62*B62/$C$13))	=13780000000	=6.915938055*10^-12	=C62*B62/A62	=C13*9.50005261095*C62*B62/D62	= D62/E62
=LN(1/(1-C63*B63/$C$13))	=13780725000	=6.916147100*10^-12	=C63*B63/A63	=C13*9.50005261095*C63*B63/D63	=D63/E63
=LN(1/(1-C64*B64/$C$13))	=13780745000	=6.916149680*10^-12	=C64*B64/A64	=C13*9.50005261095*C64*B64/D64	=D64/E64
=LN(1/(1-C65*B65/$C$13))	=13780742500	=6.916149358*10^-12	=C65*B65/A65	=C13*9.50005261095*C65*B65/D65	=D65/E65
=LN(1/(1-C66*B66/$C$13))	=13780742800	=6.916149395*10^-12	=C66*B66/A66	=C13*9.50005261095*C66*B66/D66	=D66/E66
=LN(1/(1-C67*B67/$C$13))	=13780742830	=6.916149398*10^-12	=C67*B67/A67	=C13*9.50005261095*C67*B67/D67	=D67/E67
=LN(1/(1-C68*B68/$C$13))	=13780742831	=6.916149399*10^-12	=C68*B68/A68	=C13*9.50005261095*C68*B68/D68	=D68/E68
69					
70					

DATA SHEET

Time $t/10^9$	Speed v(t) D_{me}*c multiplied by	current g(t) 1.44*Δv(t)/1.44	CAM Gravity G(t) v/t divided by	BB's Gravity G(t) (c/2)/t=(L/2)/t^2	Total Gravity g(t)+G(t)+G(t)
t_{n+1}=1.440211037065*t_n	0.951550741	ajusted = 3.6*g(t)	9.983768635		adjusted
0.0000000010	0.00000000E+00	0.00000000E+00	0.00000000E+00	5.00000000E-01	5.00000000E-01
0.0000000014	7.57662011E-10	2.72758324E-09	5.26932359E-02	2.41055883E-01	2.93749121E-01
0.000000002	1.42037245E-09	2.38575760E-09	6.85891568E-02	1.16215877E-01	1.84805036E-01
0.000000003	2.31847565E-09	3.23317149E-09	7.77373310E-02	5.60290418E-02	1.33766376E-01
0.000000004	3.58669947E-09	4.56560575E-09	8.35018199E-02	2.70122603E-02	1.10514085E-01
0.000000006	5.39937318E-09	6.52562538E-09	8.72806884E-02	1.30229285E-02	1.00303623E-01
0.000000009	8.00167737E-09	9.36829507E-09	8.98110388E-02	6.27850705E-03	9.60895552E-02
0.000000013	1.17442658E-08	1.34733183E-08	9.15268297E-02	3.02694212E-03	9.45537853E-02
0.000000019	1.71309310E-08	1.93919949E-08	9.26994976E-02	1.45932441E-03	9.41588414E-02
0.000000027	2.48865633E-08	2.79202762E-08	9.35050799E-02	7.03557469E-04	9.42086653E-02
0.000000038	3.60547548E-08	4.02054893E-08	9.40603716E-02	3.39193333E-04	9.43996051E-02
0.000000055	5.21382471E-08	5.79005722E-08	9.44440135E-02	1.63529097E-04	9.46076005E-02
0.000000080	7.53011427E-08	8.33864244E-08	9.47094776E-02	7.88393017E-05	9.47884003E-02
0.000000115	1.08660100E-07	1.20092245E-07	9.48933630E-02	3.80093549E-05	9.49314924E-02
0.000000165	1.56703690E-07	1.72956926E-07	9.50208319E-02	1.83247572E-05	9.50393296E-02
0.000000238	2.25896357E-07	2.49093599E-07	9.51092367E-02	8.83458106E-06	9.51183204E-02
0.000000343	3.25548225E-07	3.58746724E-07	9.51705691E-02	4.25925547E-06	9.51751871E-02
0.000000493	4.69067812E-07	5.16670514E-07	9.52131278E-02	2.05343718E-06	9.52156979E-02
0.000000711	6.75766188E-07	7.44114154E-07	9.52426615E-02	9.89986223E-07	9.52443956E-02
0.000001024	9.73455336E-07	1.07168093E-06	9.52631550E-02	4.77284006E-07	9.52647040E-02
0.000001474	1.40219033E-06	1.54344598E-06	9.52773707E-02	2.30104235E-07	9.52791443E-02
0.000002123	2.01965884E-06	2.22288662E-06	9.52872241E-02	1.10935959E-07	9.52895579E-02
0.000003058	2.90894307E-06	3.20142325E-06	9.52940420E-02	5.34835311E-08	9.52972969E-02
0.000004404	4.18969857E-06	4.61071979E-06	9.52987425E-02	2.57850396E-08	9.53033790E-02
0.000006342	6.03425374E-06	6.64039860E-06	9.53019582E-02	1.24312710E-08	9.53086111E-02
0.000009134	8.69079616E-06	9.56355271E-06	9.53041221E-02	5.99326200E-09	9.53136917E-02
0.000013155	1.25167648E-05	1.37734872E-05	9.53055253E-02	2.88942212E-09	9.53193017E-02
0.000018945	1.80269401E-05	1.98366310E-05	9.53063567E-02	1.39302440E-09	9.53261947E-02
0.000027285	2.59626993E-05	2.85687331E-05	9.53067281E-02	6.71593454E-10	9.53352975E-02
0.000039297	3.73917510E-05	4.11445860E-05	9.53066896E-02	3.23783106E-10	9.53478345E-02
0.000056596	5.38517561E-05	5.92560184E-05	9.53062359E-02	1.56099645E-10	9.53654921E-02
0.000081510	7.75571368E-05	8.53393705E-05	9.53053060E-02	7.52574755E-11	9.53906455E-02
0.000117391	1.11696850E-04	1.22902967E-04	9.53037749E-02	3.62825144E-11	9.54266779E-02
0.000169068	1.60863089E-04	1.76998461E-04	9.53014366E-02	1.74922271E-11	9.54784351E-02
0.000243494	2.31668385E-04	2.54899065E-04	9.52979765E-02	8.43320848E-12	9.55528755E-02
0.000350683	3.33633694E-04	3.67075112E-04	9.52929292E-02	4.06574903E-12	9.56600043E-02
0.000505058	4.80466053E-04	5.28596493E-04	9.52856162E-02	1.96014544E-12	9.58142127E-02
0.000727389	6.91895810E-04	7.61147126E-04	9.52750541E-02	9.45009181E-13	9.60362013E-02
0.001047594	9.96316689E-04	1.09591517E-03	9.52598239E-02	4.55600045E-13	9.63557390E-02
0.001508757	1.43457575E-03	1.57773261E-03	9.52378798E-02	2.19650142E-13	9.68156125E-02
0.002172928	2.06540624E-03	2.27098977E-03	9.52062773E-02	1.05895918E-13	9.74772671E-02
0.003129475	2.97319936E-03	3.26805522E-03	9.51607804E-02	5.10536680E-14	9.84288356E-02
0.004507105	4.27908810E-03	4.70119948E-03	9.50953011E-02	2.46135740E-14	9.97965006E-02
0.006491182	6.15668502E-03	6.75934892E-03	9.50010993E-02	1.18664936E-14	1.01760448E-01
0.009348672	8.85428310E-03	9.71135307E-03	9.48656450E-02	5.72097619E-15	1.04576998E-01
0.013464061	1.27258734E-02	1.39377252E-02	9.46710131E-02	2.75814993E-15	1.08608738E-01
0.019391089	1.82738571E-02	1.99727413E-02	9.43916364E-02	1.32973653E-15	1.14364378E-01
0.027927261	2.62065630E-02	2.85577410E-02	9.39912059E-02	6.41081629E-16	1.22548947E-01
0.040221149	3.75129985E-02	4.07031680E-02	9.34184808E-02	3.09072996E-16	1.34121649E-01
0.057926942	5.35543308E-02	5.77487963E-02	9.26018116E-02	1.49007728E-16	1.50350608E-01
0.083427022	7.61638137E-02	8.13941382E-02	9.14423614E-02	7.18383788E-17	1.72836500E-01
0.120152518	1.07729649E-01	1.13637008E-01	8.98065189E-02	3.46341276E-17	2.03443527E-01
0.173044982	1.51201622E-01	1.56499102E-01	8.75191179E-02	1.66975204E-17	2.44018220E-01
0.249221293	2.09904979E-01	2.11332083E-01	8.43612655E-02	8.05007106E-18	2.95693349E-01
0.358931257	2.86966425E-01	2.77421208E-01	8.00802278E-02	3.88103397E-18	3.57501436E-01
0.516936758	3.84098689E-01	3.49676151E-01	7.44236392E-02	1.87109214E-18	4.24099790E-01
0.744498024	4.99590150E-01	4.15769257E-01	6.72133914E-02	9.02075536E-19	4.82982648E-01
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1.544243633	7.48420088E-01	4.41111336E-01	4.85439496E-02	2.09671000E-19	4.89655285E-01
2.224036724	8.48620006E-01	3.60719702E-01	3.82187786E-02	1.01084856E-19	3.98938480E-01
3.203082236	9.12882803E-01	2.31346071E-01	2.85464711E-02	4.87341983E-20	2.59892542E-01
4.613114389	9.42110527E-01	1.05219807E-01	2.04556425E-02	2.34953304E-20	1.25675449E-01
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9.568557993	9.51484235E-01	4.22066731E-03	9.96002883E-03	5.46106087E-21	1.41806961E-02
13.780742831	9.51549756E-01	2.35874375E-04	6.91614940E-03	2.63284170E-21	7.15202377E-03

This is the adjustment for graphical presentation

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