COMPLEXITY GROWTH IN THE BIG HISTORY. A PRELIMINARY QUANTITATIVE ANALYSIS

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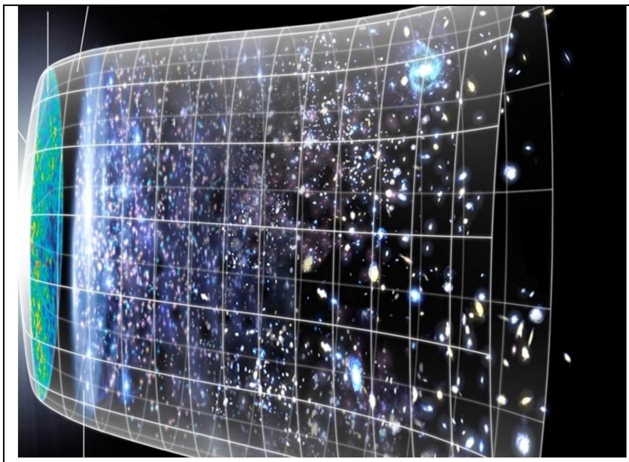
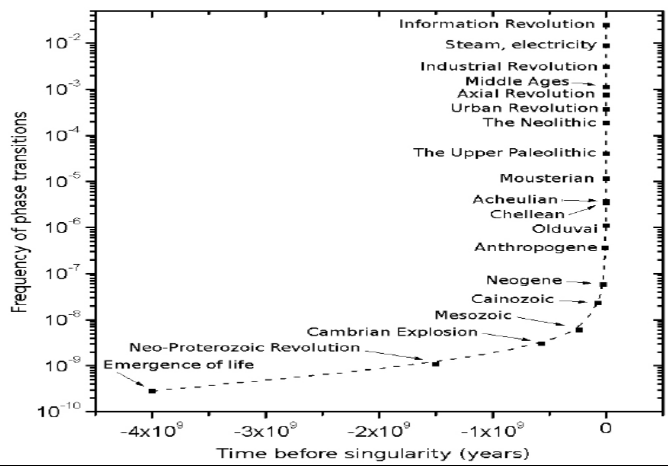




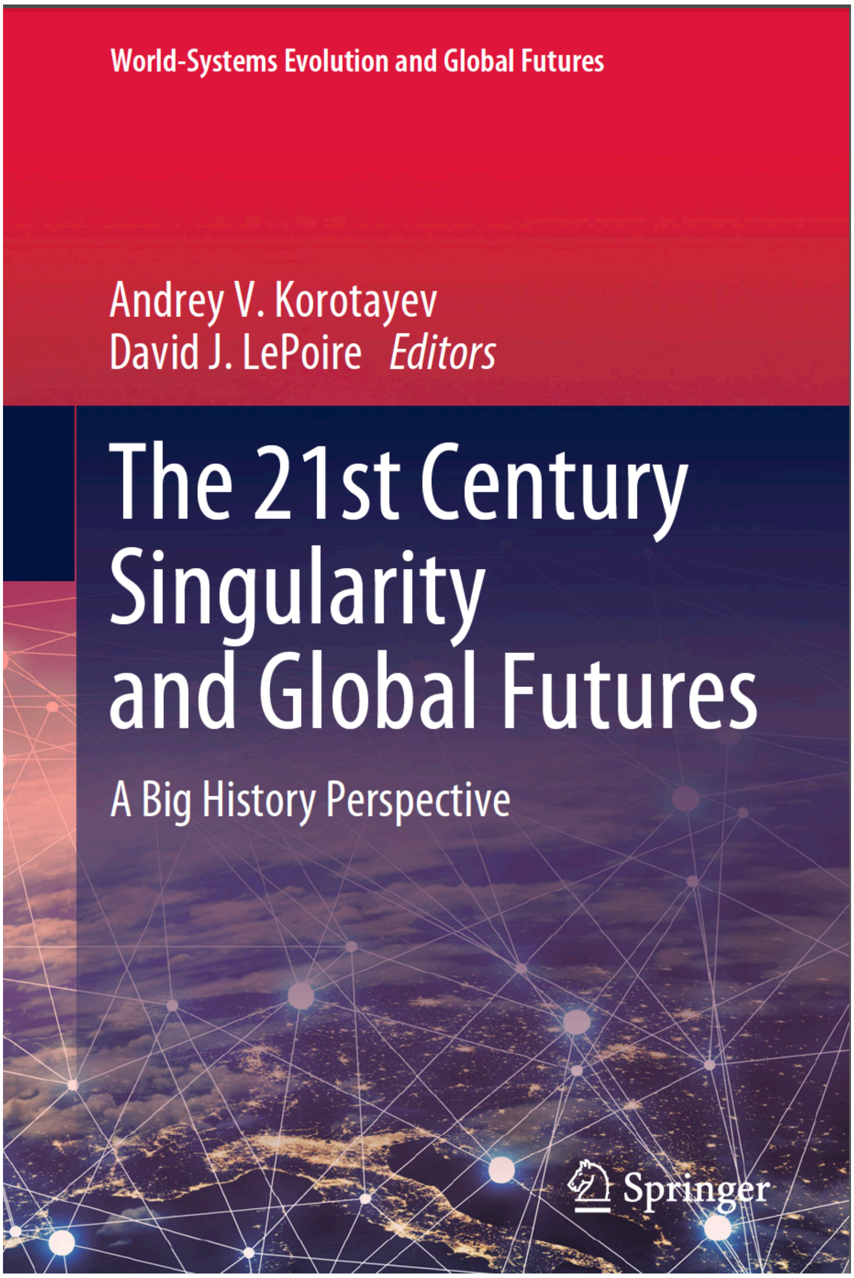
This presentation will be structured as follows.

In its first part, I present a summary of my previous systematic quantitative analysis of the accelerating global (biosocial) complexity growth observed for about 4 billion years on the planet Earth since the emergence of life on it and till the early 1970s.

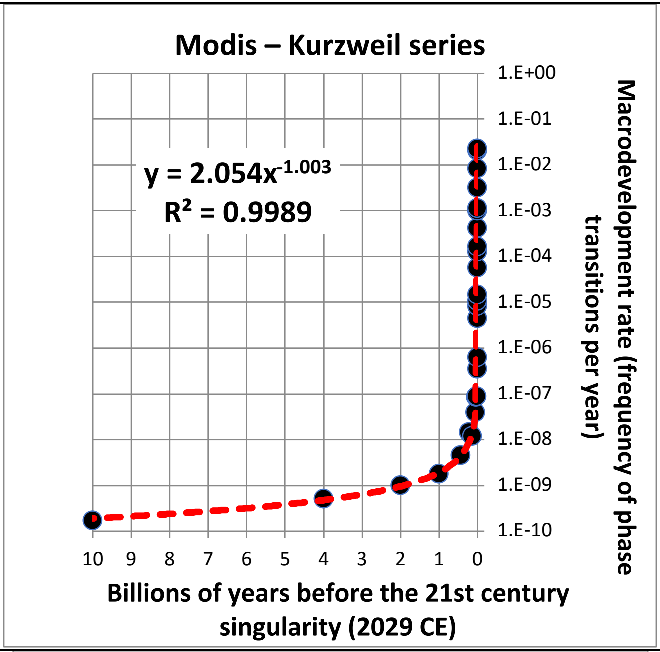
In the second part, I apply the same methodology that I have applied to analyze this accelerating pattern
to the analysis of decelerating universal (cosmic) complexity growth evidenced in the Universe for a few billions of years since the Big Bang Singularity (around 13.8 billion years BP).

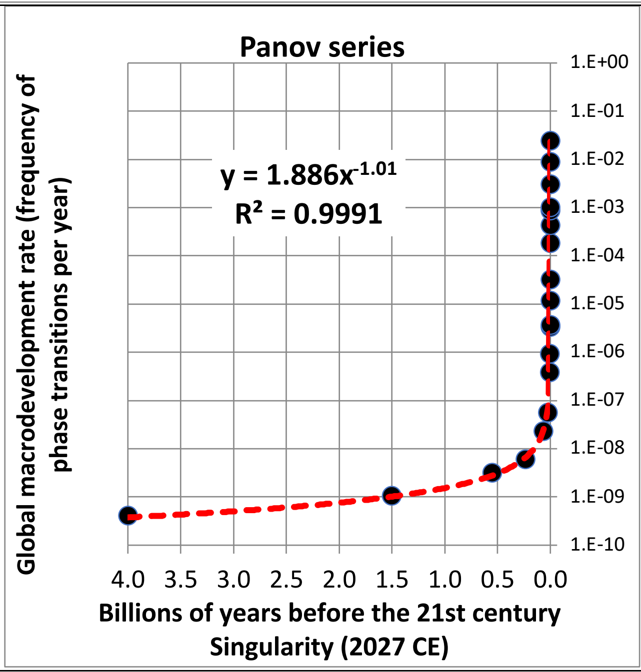
Finally, the third part offers a systematic comparison of the both patterns.

44

	**As I only have 20 minutes for my presentation, it appears impossible to describe the methodology of my previous systematic quantitative analysis of the accelerating global (biosocial) evolutionary development within such a short period of time; so, I have to limit myself to the presentation of its results. A detailed description of methodology can be found in my contribution to Springer edited volume *The 21st Century Singularity and Global Futures: A Big History Perspective*, the image of whose cover can be seen to the left.**

38 + 44 = 82 = 1' 22



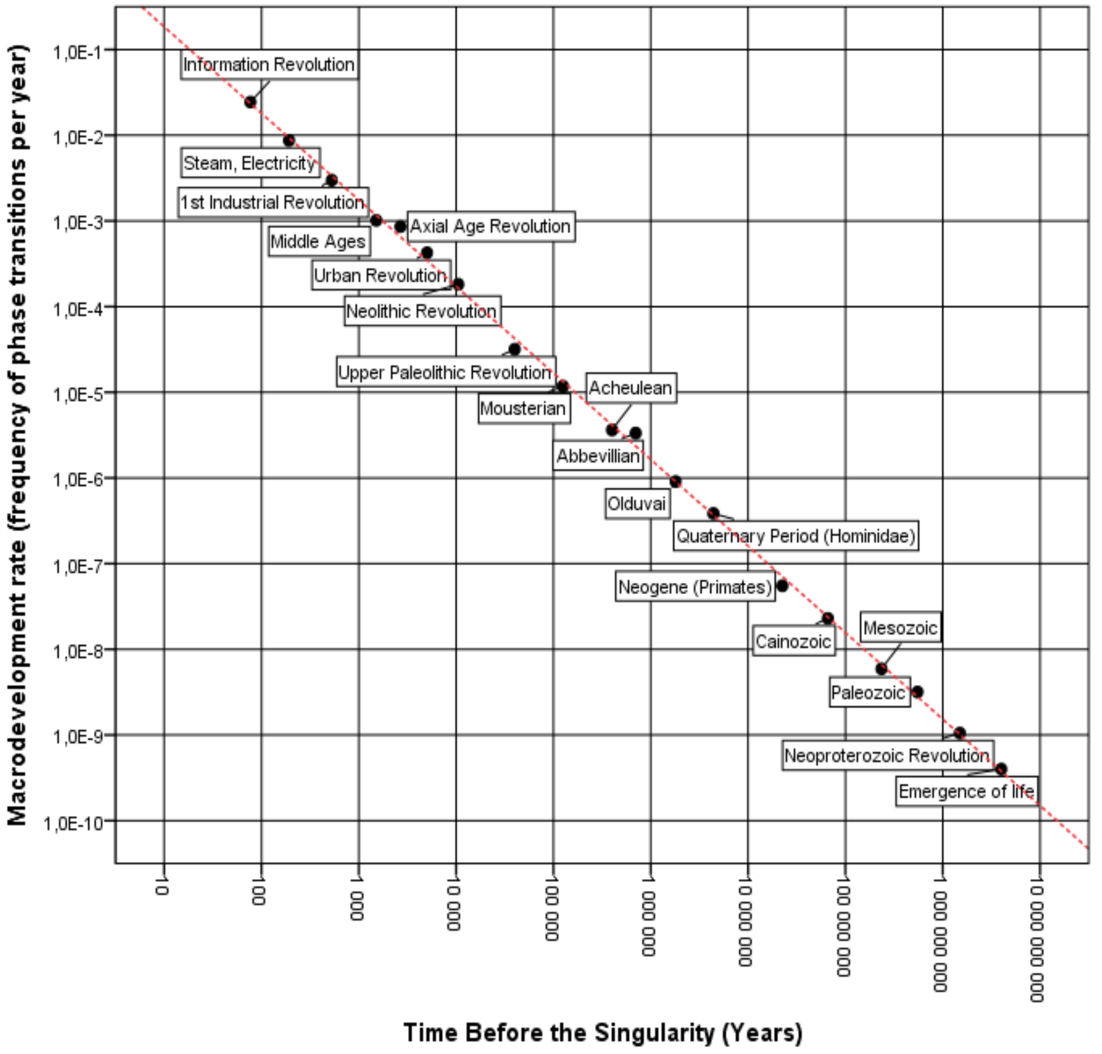


Our analysis has demonstrated that the accelerating global (biosocial) evolutionary development observed for about 4 billion years on the planet Earth since the emergence of life on it can be very accurately described by the following equation:

$$y_t = \frac{C}{t^* - t},$$

where y_t is the global macrodevelopment rate (complexity jumps per a unit of time) at time t, t^* is the time of singularity, and C is a constant. The singularity time has been identified by this analysis as being around 2027–2029 CE.

38 (82 + 38 = 120 = 2')



Here you can see the fit between the theoretical curve generated by the hyperbolic equation above and the empirical estimates produced by Alexander Panov.

12 (120 + 12 = 132 = 2' 12)

$$y = \frac{C}{t^{*} - t}$$

Thus, the general formula of the acceleration of the global complexity growth can be described as follows:

- The rate of the global complexity growth increases when we approach the Singularity.
- As the time till the Singularity decreases *n* times, the global complexity growth rate increases the same *n* times.
- Thus, if the time till the Singularity lessens by a factor of 3, the speed of the global complexity growth rises 3 times; if the time till the Singularity diminishes 10 times, the global complexity growth rate escalates by a factor of 10, and so on.

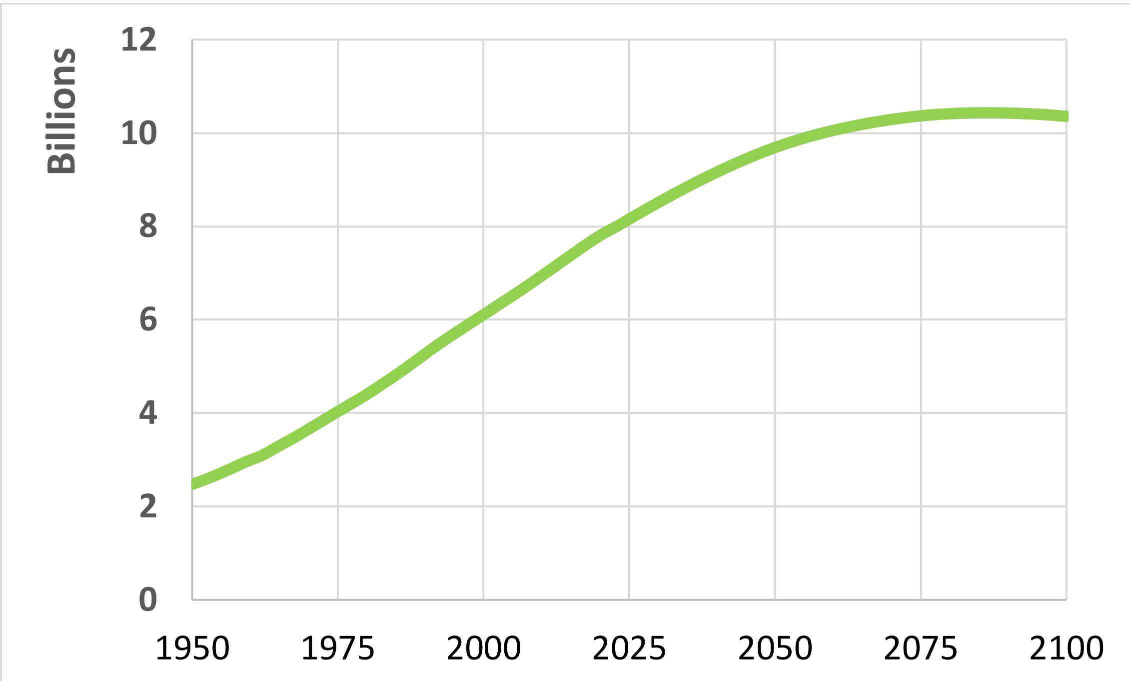
40 (132 + 40 = 172 = 2’ 52)

An important disclaimer:

- How seriously should we take the prediction of "singularity" contained in such mathematical models?
- Should we really expect with Kurzweil that around 2029 we should deal with a few orders of magnitude acceleration of the technological growth (indeed, predicted by one of equations above if we take it literally)?
- I don't think so. This is suggested, for example, by the empirical data on the world population dynamics. As we have shown earlier on quite a few occassions, the global population growth acceleration pattern discovered by Heinz von Foerster is identical with planetary macroevolutionary acceleration patterns of Modis – Kurzweil and Panov, and it is characterized by the singularity parameter (2027 CE) that is simply identical for Panov and has just 2 year difference with Modis – Kurzweil.
- However, what are the grounds to expect that by Friday, November 13, A.D. 2026 the world population growth rate will increase by a few orders of magnitude as is implied by von Foerster equation?
- The answer to this question is very clear. There are no grounds to expect this at all. Indeed, as we showed quite time ago, "von Foerster and his colleagues did not imply that the world population on [November 13, A.D. 2026] could actually become infinite. The real implication was that the world population growth pattern that was followed for many centuries prior to 1960 was about to come to an end and be transformed into a radically different pattern. Note that this prediction began to be fulfilled only in a few years after the "Doomsday" paper was published" (Korotayev 2008: 154).

118 (1073+118=1191=19' 51)

Indeed,
starting from the early 1970s
the world population growth curve
began to diverge more and more
from the almost ideal hyperbolic shape
it had before,
and in recent decades
it has been taken more and more clearly logistic shape –
the trend towards hyperbolic acceleration
has been clearly replaced
with the logistic slow-down



World population dynamics (billions), empirical estimates of the UN Population Division for 1950–2022 with its middle forecast till 2100

There are all grounds to maintain
that the deceleration of planetary macroevolutionary development
has also already begun –
and it started a few decades before the singularity time points
detected both in Modis – Kurzweil and Panov.

44 (1191+44=1235=20' 35)

The application of the same methodology
that I have applied earlier
to analyze the abovementioned accelerating pattern
to the analysis of decelerating universal (cosmic) evolutionary development
evidenced in the Universe for a few billions of years since the Big Bang Singularity
has yielded the following results.

27 (172 + 27 = 199 = 3’ 19)

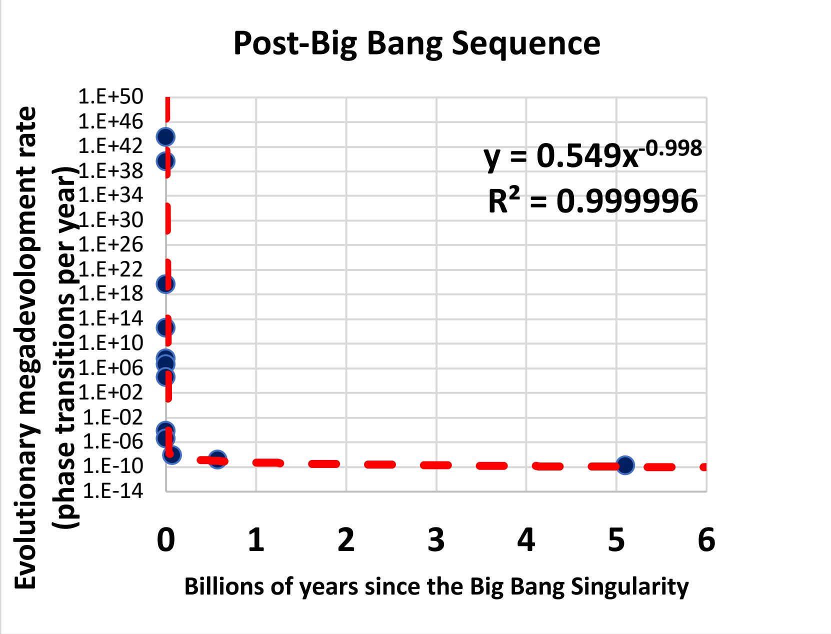
We have used the following time series for our analysis, taking into account the following phases of the universal complexity growth:

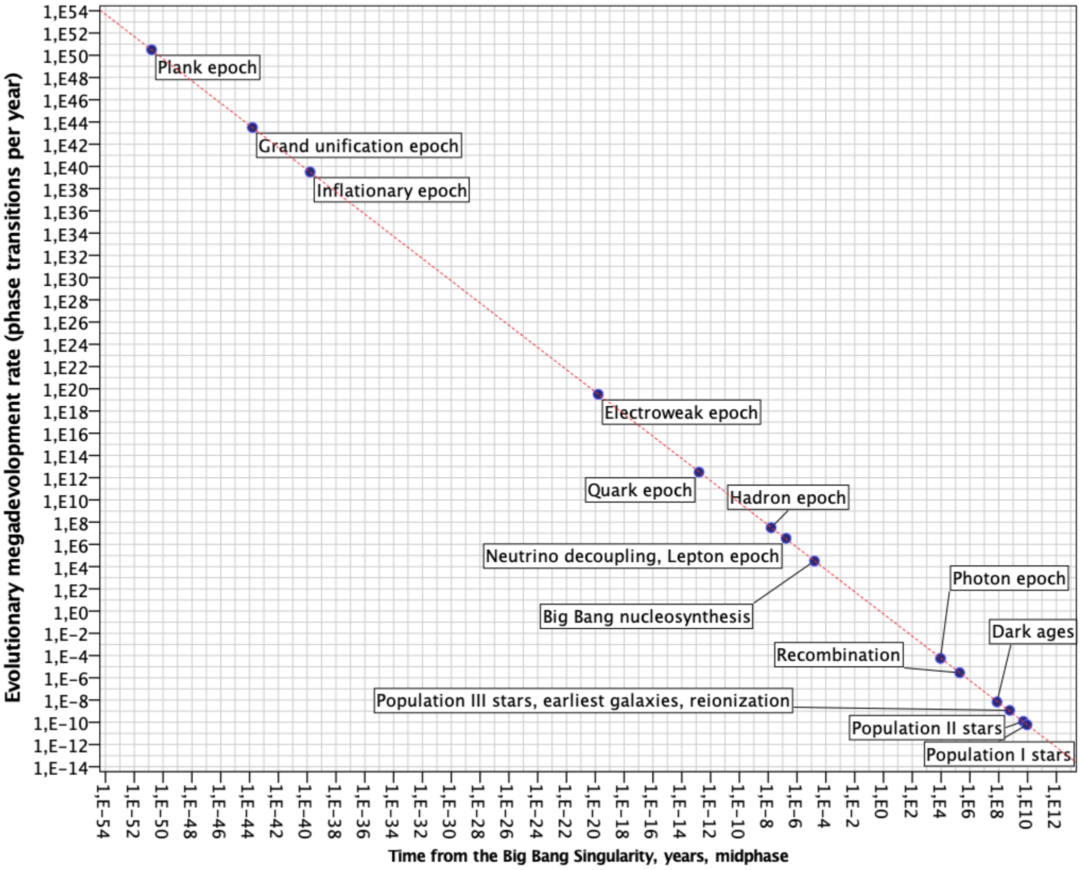
Phases of the universal complexity growth	***Seconds** since the Big Bang Singularity*	***Years** since the Big Bang Singularity (~13.8 billion years BP)*	*Time between phases (years)*	*Universal evolutionary megadevolopment rate (phase transitions per year)*
Plank epoch	**before 10^{-43}**	before $3.17*10^{-51}$		
Plank epoch > Grand unification epoch	10^{-43}	$3.17*10^{-51}$	$3.17*10^{-51}$	**$3.16*10^{50}$**
Grand unification epoch	**from 10^{-43} to 10^{-36}**	from $3.17*10^{-51}$ to $3.17*10^{-44}$		
Grand unification epoch > Inflationary epoch	10^{-36}	$3.17*10^{-44}$	$3.17*10^{-44}$	**$3.16*10^{43}$**
Inflationary epoch	**from 10^{-36} to 10^{-32}**	from $3.17*10^{-44}$ to $3.17*10^{-40}$		
Inflationary epoch > Electroweak epoch	10^{-32}	$3.17*10^{-40}$	$3.17*10^{-40}$	**$3.16*10^{39}$**
Electroweak epoch	**from 10^{-32} to 10^{-12}**	from $3.17*10^{-40}$ to $3.17*10^{-20}$		
Electroweak epoch > Quark epoch	10^{-12} (one trillionth of a second)	$3.17*10^{-20}$	$3.17*10^{-20}$	**$3.16*10^{19}$**
Quark epoch	**from 10^{-12} to 10^{-5}**	from $3.17*10^{-20}$ to $3.17*10^{-13}$		
Quark epoch > Hadron epoch	10^{-5} (0.00001, 10 millionths of a second)	$3.17*10^{-13}$	$3.17*10^{-13}$ of a year (~1 millionth of a second)	**$3.16*10^{12}$ (3.16 trillion phase transitions per year)**
Hadron epoch	**from 10^{-5} to 1 second since the Big Bang Singularity**	from $3.17*10^{-13}$ to $3.17*10^{-8}$		
Hadron epoch > Lepton epoch	1 second since the Big Bang Singularity (= after Singularity / AS)	$3.17*10^{-8}$	$3.17*10^{-8}$ of a year (~1 second)	**$3.16*10^{7}$ (31.6 million phase transitions per year)**

Phases of the universal complexity growth	***Seconds** since the Big Bang Singularity*	***Years** since the Big Bang Singularity (~13.8 billion years BP)*	*Time between phases (years)*	*Universal evolutionary megadevolopment rate (phase transitions per year)*
Lepton epoch, Neutrino decoupling	**from 1 to 10 seconds since the Big Bang Singularity / AS**	from $3.17*10^{-8}$ to $3.17*10^{-7}$		
Lepton epoch > Big Bang nucleosynthesis	10 seconds	$3.17*10^{-7}$	$2.87*10^{-7}$ of a year (~9 seconds)	**$3.51*10^{6}$ (3.51 million phase transitions per year)**
Big Bang nucleosynthesis	**from 10 to 1000 seconds AS**	from $3.17*10^{-7}$ to $3.17*10^{-5}$		
Big Bang nucleosynthesis > Photon epoch	1000 seconds	$3.17*10^{-5}$	$3.14*10^{-5}$	**$3.19*10^{4}$ (31,900 phase transitions per year)**
Photon epoch	from 1000 seconds	to 18 thousand years AS		
Photon epoch > Recombination	$5.68*10^{11}$	$1.8*10^{4}$ (18 thousand years)	$1.8*10^{4}$ (18 thousand years)	**$5.56*10^{-5}$ (5.56 phase transitions per 100 thousand years)**
Recombination	from $5.68*10^{11}$ to $1.17*10^{13}$	**from 18 thousand to 370 thousand years AS**		
Recombination > Dark ages	$1.17*10^{13}$	370 thousand years since the B. Bang Singularity	$3.52*10^{5}$ (352 thousand years)	**$2.84*10^{-6}$ (2.28 phase transitions per 1 million years)**
Dark ages mid-phase	from $1.17*10^{13}$ to $4.73*10^{15}$	**from 370 thousand to 150 million years AS**		
Dark ages > Population III stars	$4.73*10^{15}$	150 million (13.625 billion years BP)	$1.496*10^{8}$ (149.63 million years)	**$6.68*10^{-9}$ (6.68 phase transitions per 1 billion years)**

Phases of the universal complexity growth	***Seconds*** *since the Big Bang Singularity*	***Years*** *since the Big Bang Singularity (~13.8 billion years BP)*	*Time between phases (years)*	*Universal evolutionary megadevolopment rate (phase transitions per year)*
Population III stars, earliest galaxies, reionization, mid-phase	from $4.73*10^{15}$ to $3.16*10^{16}$	**from 150 million to 1 billion years AS**		
Population III stars > 2[nd] generation of stars	$3.16*10^{16}$	1 billion (12 billion years BP)	$8.5*10^{8}$ (850 million years)	**$1.18*10^{-9}$ (1.18 phase transitions per 1 billion years)**
First 3[rd] generation stars appear against the background of predominance of the 2nd generation of stars, medium complexity galaxies, primitive planets, primitive chemical evolution, mid-phase	from $3.16*10^{16}$ to $2.90*10^{17}$	**from 1 billion to 9.2 billion years AS**		
Predominance of the 2[nd] population of stars > predominance of the 3[rd] generation of stars	$2.90*10^{17}$	9.2 billion AS (4.6 billion years BP)	8.20E+09 $8.2*10^{9}$ (8.2 billion years)	**$1.22*10^{-10}$ (1.22 phase transitions per 10 billion years)**
Predominance of the 3rd generation of stars, complex galaxies, complex planets, complex chemical evolution	After $2.90*10^{17}$	**After 9.2 billion AS (after 4.6 billion years BP)**		

140 (199 + 140= 239 = 3' 59)





Our analysis has demonstrated that the decelerating universal (cosmic) evolutionary development evidenced in the Universe for a few billions of years since the Big Bang Singularity can be very accurately described by the following equation:

$$y_t = \frac{C_2}{t - t^*}$$

where y_t is the rate of the universal complexity growth (complexity jumps per a unite of time) at time t; t^* is the time of the Bing Bang singularity, and C_2 is a constant.

34 (239 + 34 = 273 = 4' 33)

Decelerating universal (cosmic) evolutionary development	**Accelerating global (biosocial) evolutionary development**
$$y = \frac{0.55}{t - t^{*}}$$	$$y = \frac{1.89}{t^{*} - t}$$
$$y = \frac{C_1}{t - t^{*}}$$	$$y = \frac{C_2}{t^{*} - t}$$
Thus, the general formula of the deceleration of the universal (cosmic) complexity growth can be described as follows: • The rate of the universal (cosmic) complexity growth decreases when we move from the Singularity. • As the time since the Singularity increases *n* times, the universal (cosmic) complexity growth rate decreases the same *n* times. • Thus, if the time since the Singularity rises by a factor of 3, the speed of the universal (cosmic) complexity growth lessens 3 times; if the time since the Singularity increases 10 times, the universal (cosmic) complexity growth rate diminishes by a factor of 10, and so on.	Whereas, the general formula of the acceleration of the global (biosocial) complexity growth can be described as follows: • The rate of the global complexity growth increases when we approach the Singularity. • As the time till the Singularity decreases *n* times, the global complexity growth rate increases the same *n* times. • Thus, if the time till the Singularity lessens by a factor of 3, the speed of the global complexity growth rises 3 times; if the time till the Singularity diminishes 10 times, the global complexity growth rate escalates by a factor of 10, and so on.
It is difficult not to see here a striking symmetry – the basic regularities of the hyperbolic deceleration of the post-Big Bang universal increase in complexity turn out to be strikingly similar to the ones of the hyperbolic acceleration of the complexity growth observed on our planet for 4 billion years until the early 1970s.	

64 (273 + 97 = 360 = 6')

Consider now the relationship
between the radiation energy of the Universe
and universal complexity growth rate
(measured in phase transitions per year).

10 (10 + 360 = 370 = 5’ 10)

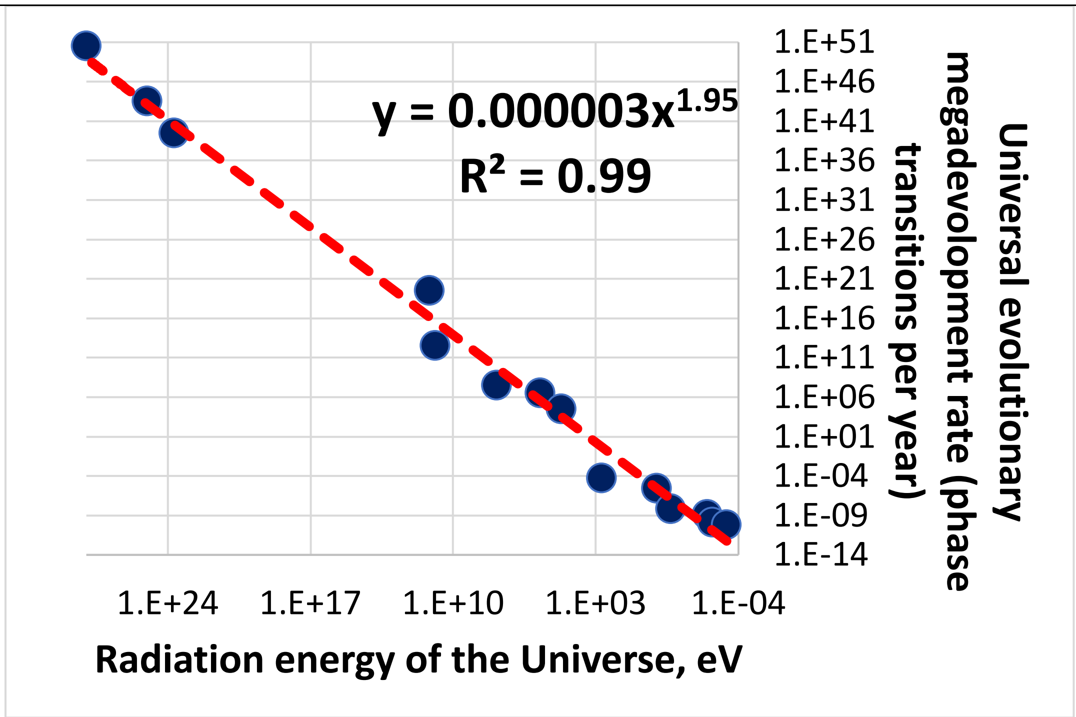
We have used the following time series for our analysis, taking into account the following phases of the universal complexity growth and corresponding values of the radiation energy of the Universe (measured in eV):

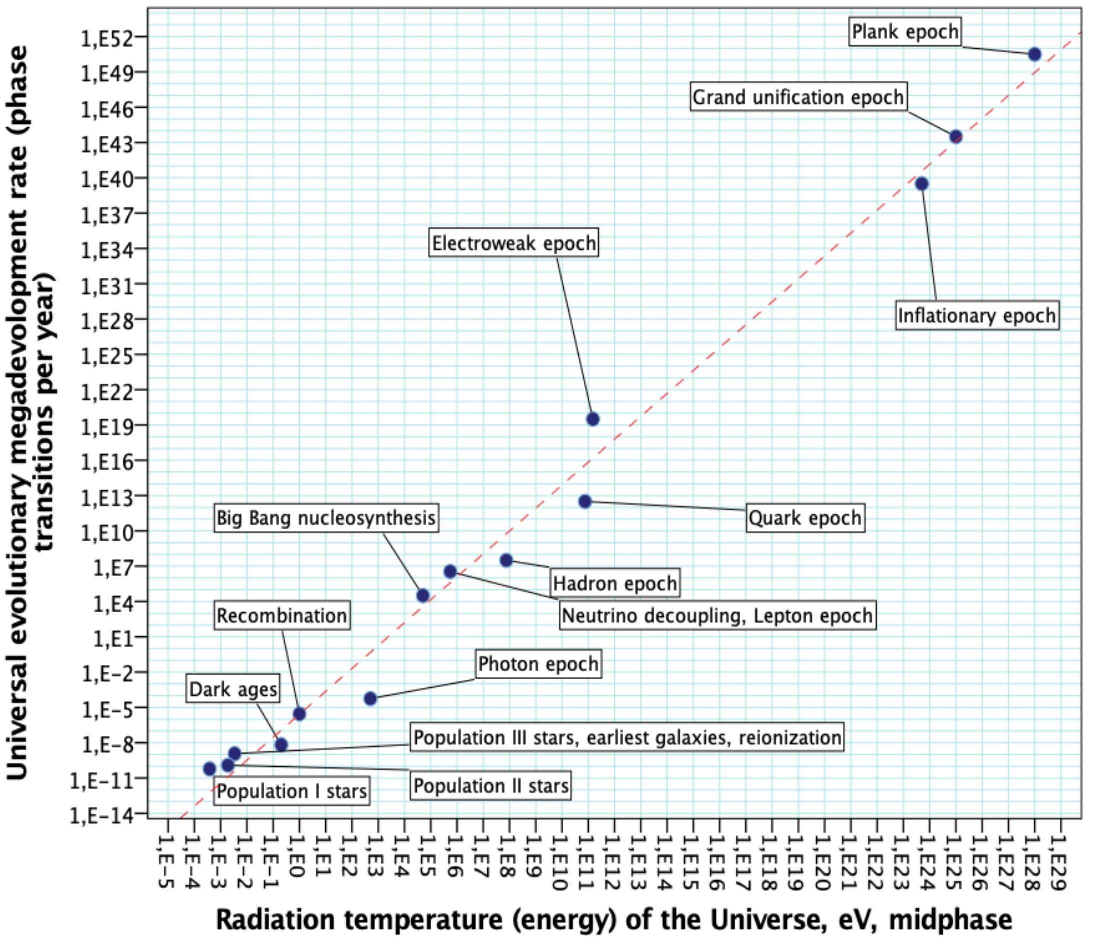
Phases of the universal complexity growth	$t - t^*$ (**seconds** since the Big Bang Singularity)	$t - t^*$ (**years** since the Big Bang Singularity)	*Time between phases (years)*	*Universal evolutionary megade-volopment rate (phase transitions per year)*	Radiation energy of the Universe, in electronvolts (eV)	Radiation energy of the Universe, in Kelvins (K)
Plank epoch starts	10^{-47}	$3.17*10^{-55}$				
Plank epoch mid-phase	$5*10^{-44}$	**$1.58*10^{-51}$**	$3.17*10^{-51}$	**$3.16*10^{50}$**	**10^{28}**	$1.16*10^{32}$
Plank epoch > Grand unification epoch	10^{-43}	$3.17*10^{-51}$				
Grand unification epoch mid-phase	$5*10^{-37}$	**$1.58*10^{-44}$**	$3.17*10^{-44}$	**$3.16*10^{43}$**	**10^{25}**	$1.16*10^{29}$
Grand unification epoch > Inflationary	10^{-36}	$3.17*10^{-44}$				
Inflationary epoch mid-phase	$5*10^{-33}$	**$1.58*10^{-40}$**	$3.17*10^{-40}$	**$3.16*10^{39}$**	**$5*10^{23}$**	$5.8*10^{27}$
Inflationary epoch > Electroweak epoch	10^{-32}	$3.17*10^{-40}$				
Electroweak epoch mid-phase	$5*10^{-13}$	**$1.58*10^{-20}$**	$3.17*10^{-20}$	**$3.16*10^{19}$**	**150 billion eV (150 GeV)**	$1.74*10^{15}$
Electroweak epoch > Quark epoch	10^{-12} (one trillionth of a second)	$3.17*10^{-20}$				
Quark epoch mid-phase	$5*10^{-06}$	**$1.58*10^{-13}$**	$3.17*10^{-13}$ of a year (~1 millionth of a second)	**$3.16*10^{12}$ (3.16 trillion phase transitions per year)**	**75.1 billion eV (75.1 GeV)**	$8.71*10^{14}$ (871 trillion K)
Quark epoch > Hadron epoch	10^{-05} (0.00001, 10 millionths of a second)	$3.17*10^{-13}$				
Hadron epoch mid-phase	0.500005	**$1.58*10^{-8}$**	$3.17*10^{-8}$ of a year (~1 second)	**$3.16*10^{7}$ (31.6 million phase transitions per year)**	**75.5 million eV (75.5 MeV)**	$8.76*10^{11}$ (876 billion K)

Phases of the universal complexity growth	$t - t^*$ (**seconds** since the Big Bang Singularity)	$t - t^*$ (**years** since the Big Bang Singularity)	*Time between phases (years)*	*Universal evolutionary megade-volopment rate (phase transitions per year)*	Radiation energy of the Universe, in electronvolts (eV)	Radiation energy of the Universe, in Kelvins (K)
Hadron epoch > Lepton epoch	1 second since the Big Bang Singularity	$3.17*10^{-8}$				
Lepton epoch, Neutrino decoupling, mid-phase	5.5 seconds	**$1.74*10^{-7}$**	$2.87*10^{-7}$ of a year (~9 seconds)	**$3.51*10^{6}$ (3.51 million phase transitions per year)**	**550,000 (550 KeV)**	$6.38*10^{9}$ (6.38 billion K)
Lepton epoch > Big Bang nucleosynthesis	10 seconds	$3.17*10^{-7}$				
Big Bang nucleosynthesis mid-phase	505 seconds	**$1.60*10^{-5}$**	$3.14*10^{-5}$	**$3.19*10^{4}$ (31,900 phase transitions per year)**	**50,500 (50.5 KeV)**	$5.86*10^{8}$ (586 million K)
Big Bang nucleosynthesis > Photon epoch	1000 seconds	$3.17*10^{-5}$				
Photon epoch mid-phase	$2.84*10^{11}$	**$9.0*10^{3}$ (9 thousand years since the B. Bang Singularity)**	$1.8*10^{4}$ (18 thousand years)	**$5.56*10^{-5}$ (5.56 phase transitions per 100 thousand years)**	**500 eV**	$5.86*10^{6}$ (5.86 million K)
Photon epoch > Recombination	$5.68*10^{11}$	$1.8*10^{4}$ (18 thousand years)				
Recombination mid-phase	$6.12*10^{12}$	**194 thousand years AS**	$3.52*10^{5}$ (352 thousand years)	**$2.84*10^{-6}$ (2.28 phase transitions per 1 million years)**	**1 eV**	$1.16*10^{4}$ (11.6 thousand K)
Recombination > Dark ages	$1.17*10^{13}$	370 thousand years since the B. Bang Singularity				
Dark ages mid-phase	$2.37*10^{15}$	**75.2 million (13.7 billion years BP)**	$1.496*10^{8}$ (149.63 million years)	**$6.68*10^{-9}$ (6.68 phase transitions per 1 billion years)**	**0.203 eV**	2,350 K
Dark ages > Population III stars	$4.73*10^{15}$	150 million (13.625 billion years BP)				
Population III stars, earliest galaxies, reionization, mid-phase	$1.81*10^{16}$	**575 million (13.2 billion years BP)**	$8.5*10^{8}$ (850 million years)	**$1.18*10^{-9}$ (1.18 phase transitions per 1 billion years)**	**0.0034 eV**	39.5 K
Population III stars > 2nd generation of stars	$3.16*10^{16}$	1 billion (12 billion years BP)				

Phases of the universal complexity growth	*t – t** (**seconds** since the Big Bang Singularity)	*t – t** (**years** since the Big Bang Singularity)	*Time between phases (years)*	*Universal evolutionary megade-volopment rate (phase transitions per year)*	Radiation energy of the Universe, in electronvolts (eV)	Radiation energy of the Universe, in Kelvins (K)
First 3rd generation stars appear against the background of predominance of the 2nd generation of stars, medium complexity galaxies, primitive planets, primitive chemical evolution, mid-phase	$1.61*10^{17}$	**5.1 billion (8,7 billion years BP)**	8.20E+09 $8.2*10^{9}$ (8.2 billion years)	**$1.22*10^{-10}$ (1.22 phase transitions per 10 billion years)**	**$1.89*10^{3}$ eV**	22 K
Predominance of the 2nd population of stars > predominance of the 3rd generation of stars	$2.90*10^{17}$	9.2 billion (4.6 billion years BP)				
Predominance of the 3rd generation of stars, complex galaxies, complex planets, complex chemical evolution	After $2.90*10^{17}$	After 9.2 billion years AS (after 4.6 billion years BP)	?	?	**$3.79*10^{-4}$ eV**	4.4 K

55 (370 + 55 = 425 = 7' 5)





Our analysis has demonstrated that the relationship between the radiation energy of the Universe and universal complexity growth rate can be very accurately described by the following equation:

$$y = C_4 * E^2$$

where *y* is the rate of the universal complexity growth (complexity jumps per a unit of time); *E* is the radiation energy of the Universe (eV), and C_4 is a constant.

27 (425 + 27 = 452 = 7' 32)

$$y = C_4 * E^2$$

Thus, in the cosmic history
the rate of the universal complexity growth
was proportional to the radiation energy
of the Universe squared.

10 (452 + 10 = 462 = 7’ 42)

It can be easily shown analytically that if within the cosmic evolution the rate of the universal complexity growth *y* equals constant C_1 divided by the time since the Big Bang Singularity ($t - t^*$, or x)

$$y = \frac{C_1}{t - t^*}$$

and the rate of the universal complexity growth *y* is proportional to the radiation energy of the Universe *E* squared

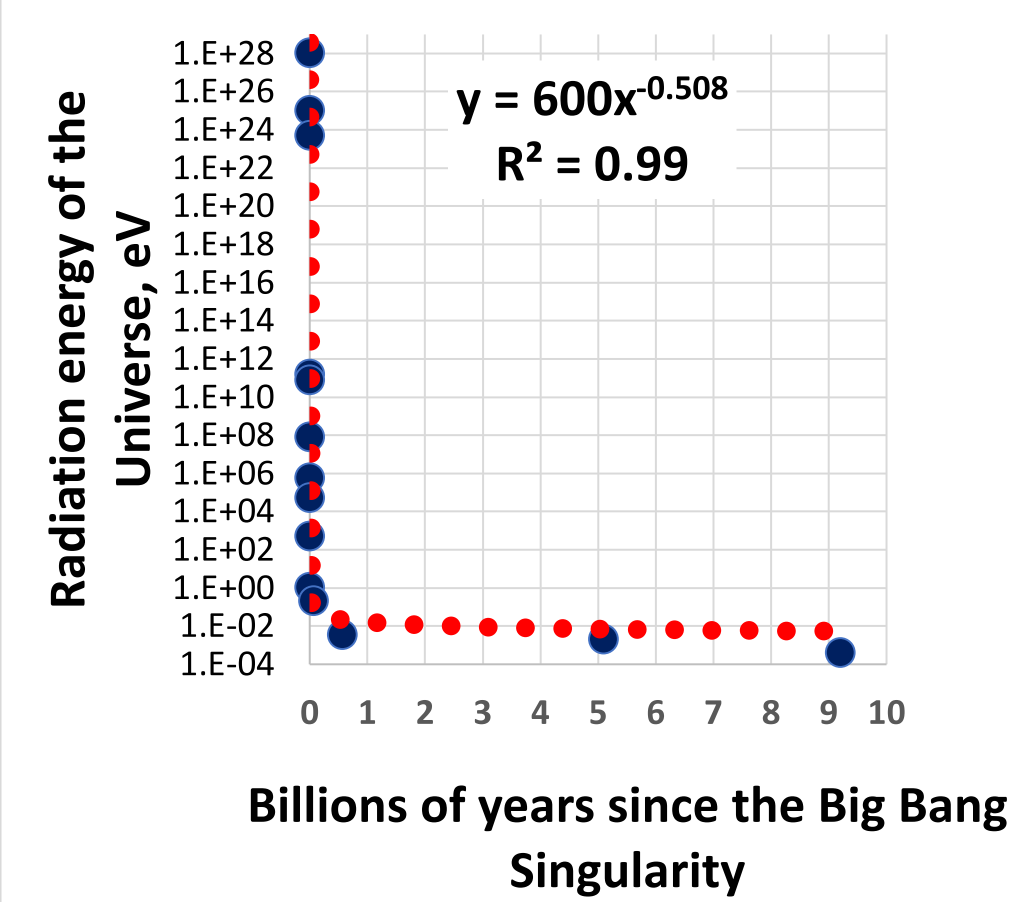
$$y = C_4 * E^2$$

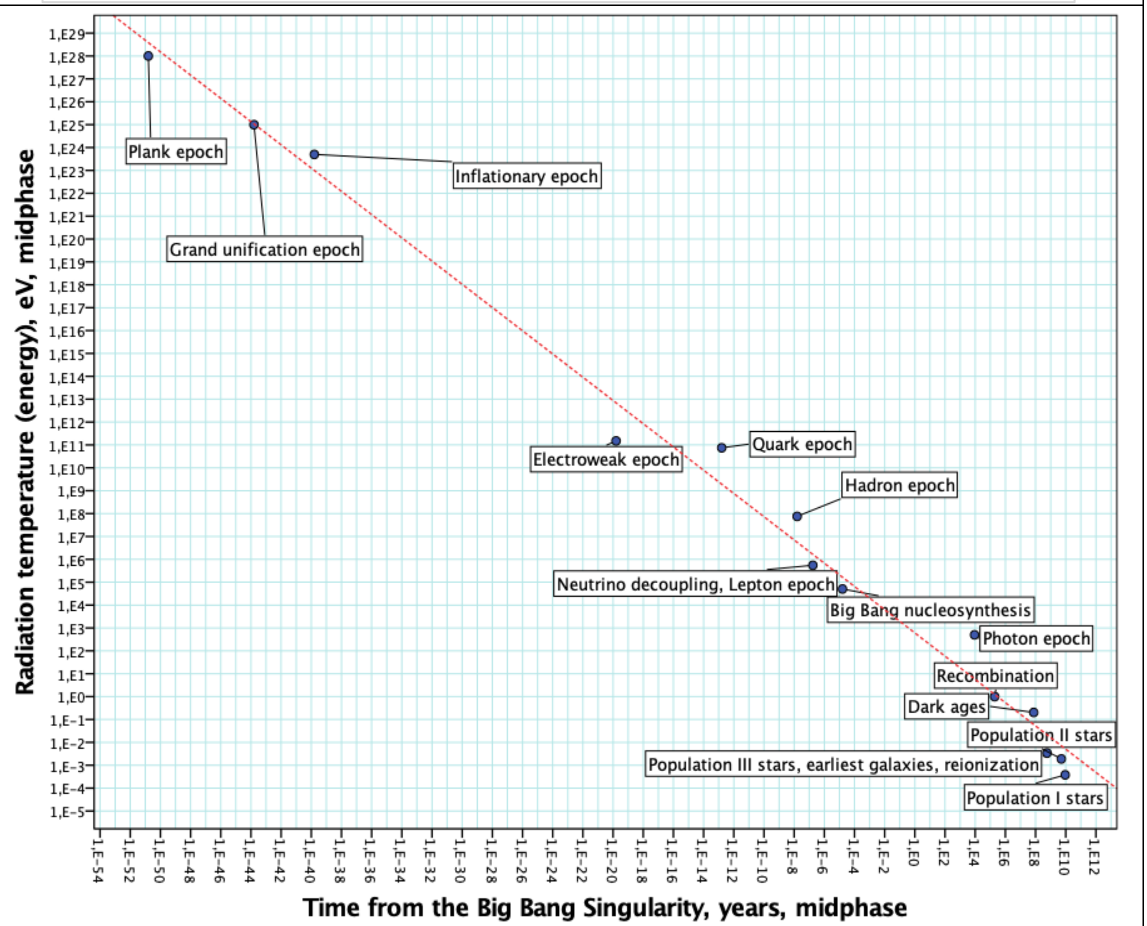
then the radiation energy of the Universe *E* should be proportional to some constant C_3 (= C_1/C_4) divided by a square root of the time since the Big Bang Singularity ($t - t^*$, or x)

$$\boldsymbol{E} = \frac{C_3}{\sqrt{\boldsymbol{t}-\boldsymbol{t}^*}} = C_3 x^{-0.5} = C_3 x^{-\frac{1}{2}}$$

$y = \frac{C_1}{t-t^*}$	$y = C_4 * E^2$
$C_4 * E^2 = \frac{C_1}{t-t^*}$	
$E^2 = \frac{C_1}{C_4} \frac{1}{t-t^*}$	
$E^2 = \frac{C_3}{t-t^*}$, where $C_3 = \frac{C_1}{C_4}$	
$E = \frac{C_3}{\sqrt{t - t^*}} = C_3 x^{-0.5}$	

27 (462 + 27 = 489 = 8' 9)





The analysis of the data presented above suggests that this is indeed the case. Our analysis has demonstrated that the relationship between time since the Big Bang Singularity (years) and radiation energy of the Universe (eV) can be quite accurately described by the following equation:

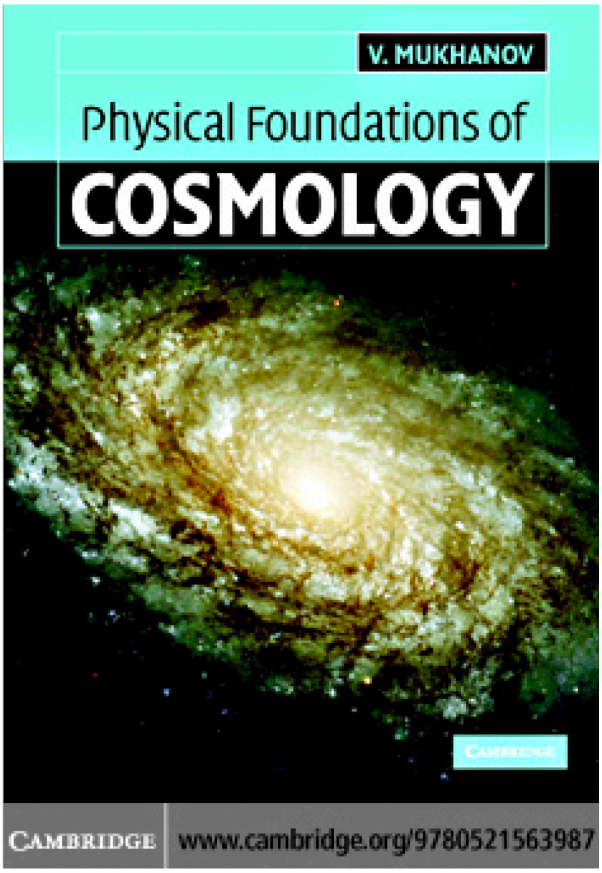
$$\boldsymbol{E} = \frac{C_3}{\sqrt{\boldsymbol{t} - \boldsymbol{t}^*}}$$

or

$$\boldsymbol{E} = C_3 x^{-0.5}$$

where *E* is the radiation energy of the Universe (eV); *x* (or $t - t^*$) is the time since the Big Bang Singularity, and C_3 is a constant.

30 (489 + 30 = 519 = 8' 39)



72 *The hot universe*

Problem 3.3 Dark energy with equation of state $w = -1/3$ leads to a term $\propto 1/a^2$ in the Friedmann equation (1.67). How can we nevertheless distinguish it from the spatial curvature term, k/a^2, in an open universe?

3.2 Brief thermal history

The temperature of the cosmic radiation decreases as the universe expands. It is unambiguously related to the redshift,

$$T_\gamma(z) = T_{\gamma 0}(1+z), \quad (3.4)$$

and can be used as an alternative to time or redshift to parameterize the history of the universe. To obtain an estimate for the temperature expressed in MeV, at the time t measured in seconds, we can use the formula

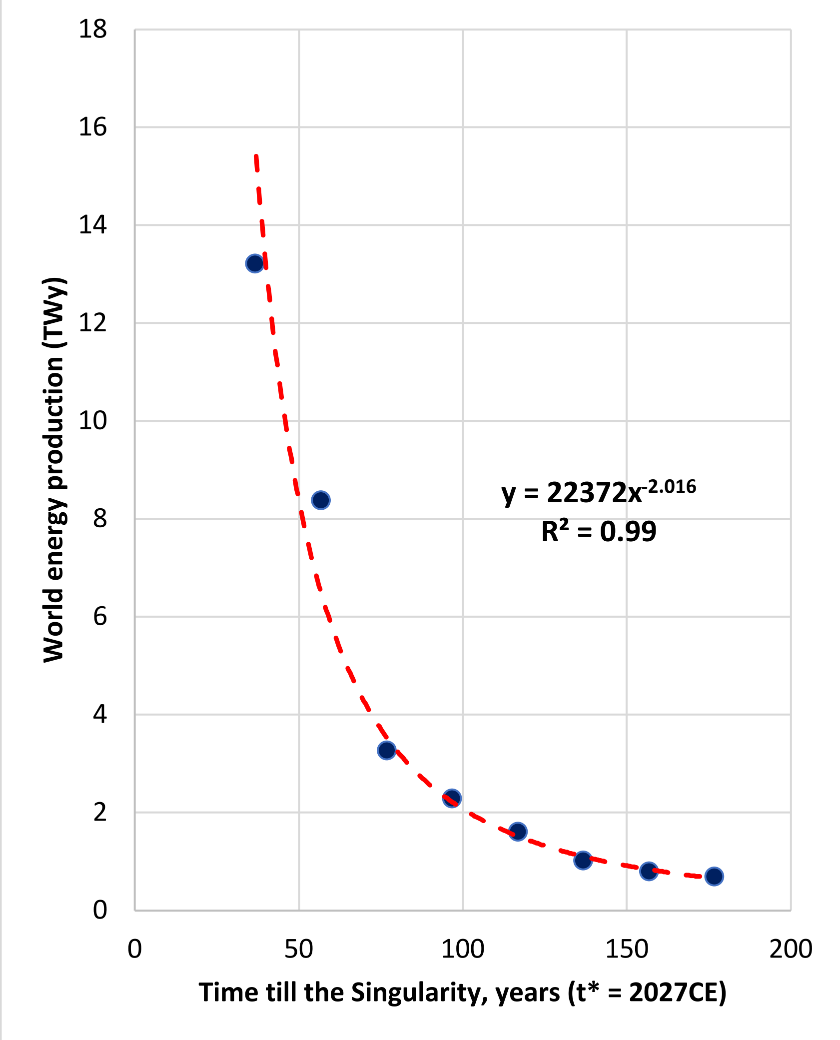
$$T_{\mathrm{MeV}} \simeq \frac{O(1)}{\sqrt{t_{\mathrm{sec}}}},$$

In fact, this relationship is well known in cosmology and may be derived from original Friedman's equations.

This suggests that the post-Big Bang hyperbolic deceleration of the universal complexity growth was directly connected with the post-Big Bang hyperbolic deceleration of the cooling of the Universe described by the equation below

$$\boldsymbol{E} = \frac{C_3}{\sqrt{\boldsymbol{t} - \boldsymbol{t}^*}}$$

22 (519 + 22 = 541 = 9' 1



Consider now the relationship between time till the 21st century singularity (years) and world energy production (TWy) estimated by John Holdren.

As we see, for the pattern of global hyperbolic acceleration we find a quadratic relationship between the energy production and the time till the singularity inversed to the one we saw with respect to the post-Big-Bang universal deceleration

$$E = \frac{C_6}{(t^* - t)^2}$$

25 (541 + 25 = 566 = 9' 26

Correspondingly the relationship between world energy production (***E***, TWy)
and global (biosocial) evolutionary megadevolopment rate (***y***, phase transitions per year)
is described by the following equation

$$\boldsymbol{y = C_5\sqrt{E}}$$

11 (566 + 11 = 577 = 9' 37)

<table>
<tr><th colspan="2">Decelerating universal (cosmic) evolutionary development</th><th colspan="2">Accelerating global (biosocial) evolutionary development</th><td rowspan="3">Thus, the correlations between energy and decelerating growth of universal complexity display a striking symmetry with inversions in comparison with accelerating global evolutionary development.

In the cosmic history the rate of the universal complexity growth was proportional to the radiation energy of the Universe squared.

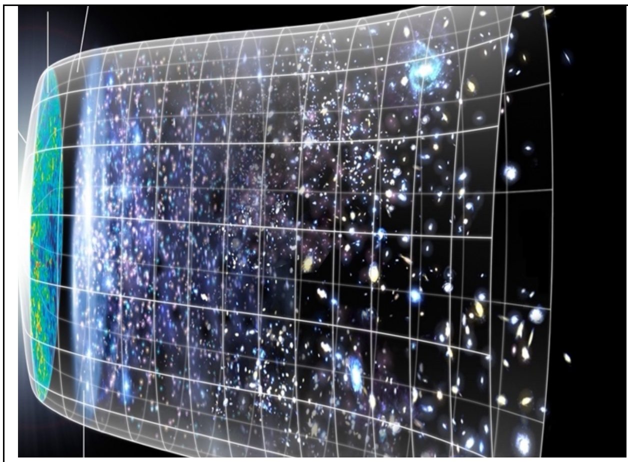
In the global history the rate of the global complexity growth was proportional to the square root of the world energy production.</td></tr>
<tr><td>Relationship between time since the Big Bang Singularity (t-t*, years) and universal evolutionary megadevolopment rate (y, phase transitions per year)</td><td>$y = \frac{C_1}{t - t^*}$</td><td>Relationship between time till the 21st century singularity (t*-t, years) and global (biosocial) evolutionary megadevolopment rate (y, phase transitions per year)</td><td>$y = \frac{C_2}{t^* - t}$</td></tr>
<tr><td>Relationship between radiation temperature (energy) of the Universe (E, eV) and universal evolutionary mega-development rate (y, phase transitions per year)</td><td>$y = C_4 * E^2$</td><td>Relationship between world energy production (E, TWy) and global (biosocial) evolutionary mega-development rate (y, phase transitions per year)</td><td>$y = C_5\sqrt{E}$</td></tr>
</table>

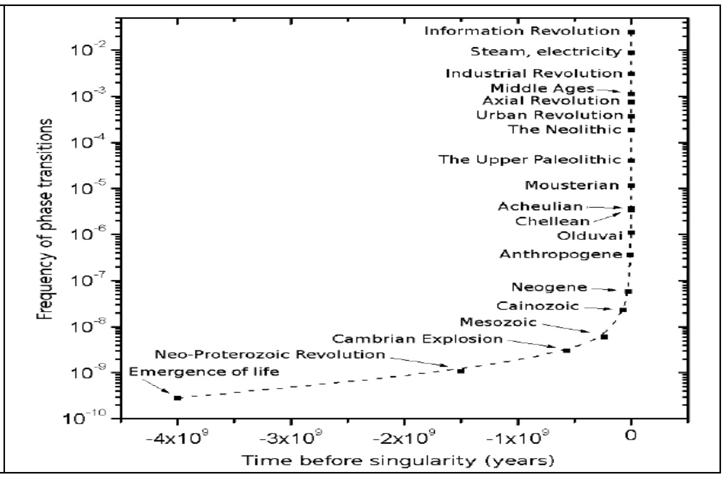
Relationship between time since the Big Bang Singularity (***t*-*t****, years) and radiation energy of the Universe (***E***, eV)	$\boldsymbol{E} = \frac{C_3}{\sqrt{\boldsymbol{t} - \boldsymbol{t}^*}}$	Relationship between time till the 21st century singularity (***t**** - ***t***, years) and world energy production (***E***, TWy)	$\boldsymbol{E} = \frac{C_6}{(\boldsymbol{t}^* - \boldsymbol{t})^2}$	In the cosmic history the moving from the Big Bang Singularity by *n* times was accompanied by the decrease of the radiation energy of the Universe by $\sqrt{n}$ times. Thus, the increase in the time since the Singularity by a factor of 4 was associated with the drop in the radiation energy of the Universe by a factor of 2.
On the other hand, in the global history the moving toward the 21st century singularity by *n* times was associated with growth of the world energy production by n^2 times. Thus, the decrease in the time till the singularity by a factor of 4 was associated with the increase in the world energy production by a factor of 16.				

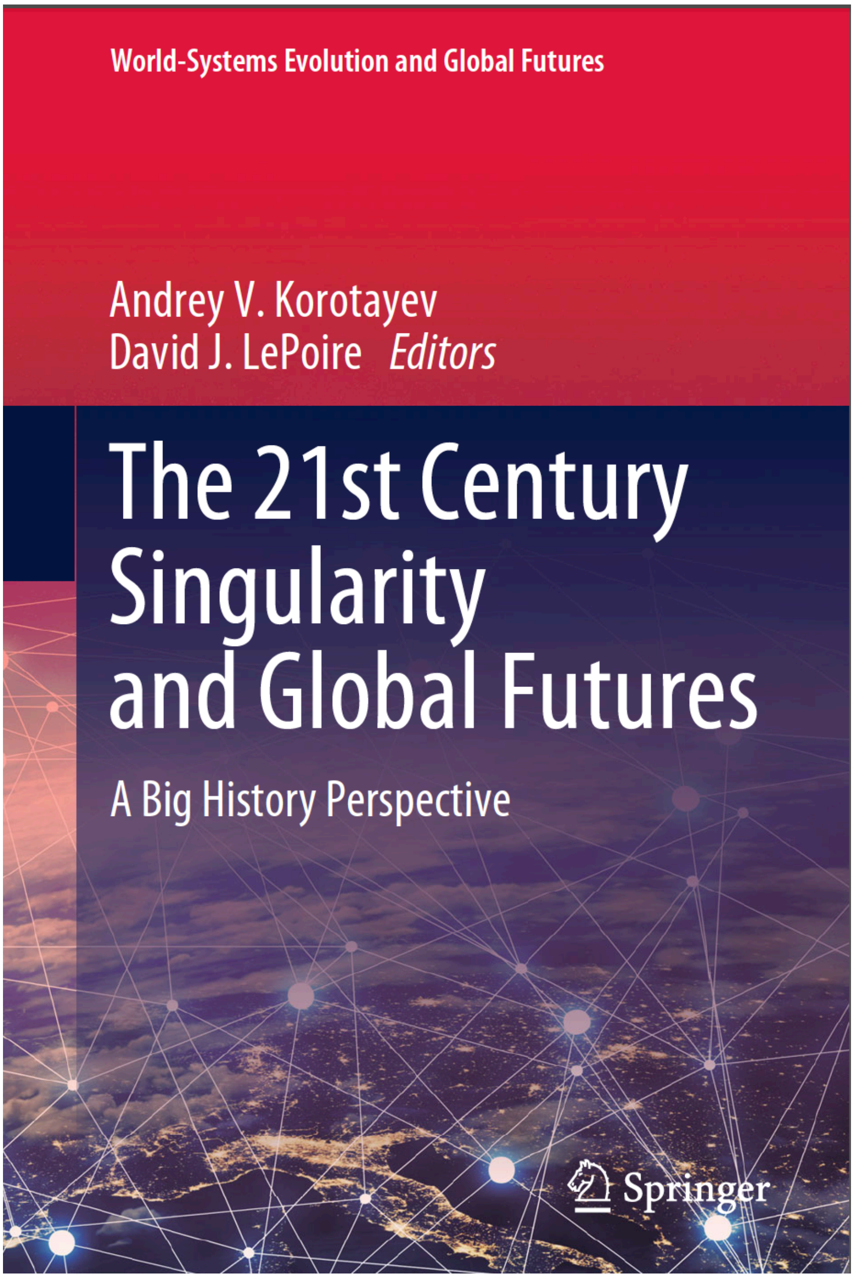
80 (577 + 80 = 657 = 10' 57)

Of course, this presentation poses more questions than it answers. The most important of those questions seems to be – why do the basic regularities of the hyperbolic deceleration of the post-Big Bang universal increase in complexity turn out to be so strikingly similar to the ones of the global hyperbolic acceleration of the complexity growth when their mechanisms are so different?

24 (657 + 24 = 681 = 11' 21)







On the one hand, it has been shown
that the global hyperbolic acceleration pattern of the last 4 billion years appears to have been produced endogenously by the second order positive feedback between the complexity of the global sociobiological system and the rate of its complexity growth:

the more complex the global biosocial system, the less time it takes it to make the next complexity jump.

It has been shown that when written mathematically,
such a feedback produces precisely a hyperbolic acceleration effect.

38 + 44 = 82 = 1’ 22

On the other hand, the hyperbolic deceleration of the post-Big-Bang of the universal complexity growth rate appears to have been produced exogenously by the post-Big-Bang hyperbolic deceleration of the cooling of the Universe: the slower this cooling proceeded, the slower the universal complexity grew – thus, the post-Big-Bang hyperbolic deceleration of the cooling of the Universe resulted in

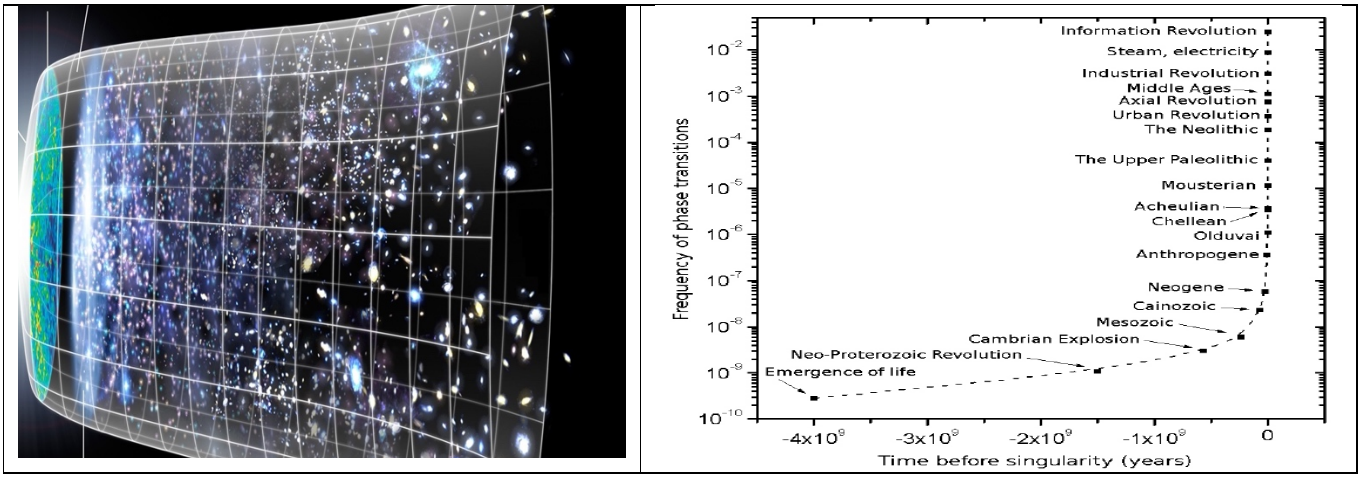
the hyperbolic deceleration of the post-Big-Bang deceleration of the universal complexity growth rate.

After the Big Bang Singularity, the growth of complexity in the Universe was very tightly connected with its cooling. It was this cooling that allowed the formation in the Universe of more and more complex entities – quarks, then hadrons, then atomic nuclei, then atoms, then molecules.

At the very beginning the cooling of the Universe proceeded very fast, and the complexity in the Universe grew extremely fast (with a few phase transitions just within the first second after the Big Bang Singularity). Then the cooling of the Universe slowed down, which caused the slowing down of the growth of complexity in the Universe.

As we have seen, the slowing down of the cooling of the Universe followed a hyperbolic pattern, and it does not appear to be of any surprise that the hyperbolic slowdown of the cooling of the Universe after the Big Bang Singularity caused a hyperbolic slowdown of the universal complexity growth rate.

Yet, those apparently so different mechanisms
appear to have produced
such strikingly similar patterns
of hyperbolic deceleration / acceleration.
Of course, this point needs further investigations.



Thank you for your attention!