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Research Article

The Cosmic Time Hypothesis (CTH)- an Extension of General Relativity.

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ABSTRACT

The "Cosmic Time Hypothesis" (CTH) presented in this paper is a purely axiomatic theory. In contrast to today's standard model of cosmology, the ΛCDM model, it does not contain empirical parameters such as the cosmological constant Λ, nor does it contain sub-theories such as the inflation theory.

The CTH was developed solely on the basis of the general theory of relativity (GRT), aiming for the greatest possible simplicity.

The simplest cosmological model permitted by ART is the Einstein-de Sitter model. It is the basis for solving some of the fundamental problems of cosmology that concern us today.

First of all, the most important results of the CTH:

- It solves one of the biggest problems of cosmology – the problem of the cosmological constant (Λ) – by removing the relation between and the vacuum energy density ε_v ($\Lambda=0$, $\varepsilon_v>0$). According to the CTH, the vacuum energy density ε_v is not negative and constant, as previously assumed, but positive and time-dependent ($\varepsilon_v \sim t^{-2}$). ε_v is part of the total energy density (Ɛ) of the universe and is contained in the energy-momentum tensor of Einstein's field equations. Cosmology is thus freed from unnecessary ballast, i.e. a free parameter (= natural constant) is omitted ($\Lambda = 0$). Conclusion: There is no "dark energy"!

- According to the CTH, the numerical value of the vacuum energy density ε_v is smaller by a factor of $\approx 10^{-122}$ than the value calculated from quantum field theory and is thus consistent with observation.

- The measurement data obtained from observations of SN lasupernovae, which suggest a currently accelerated expansion of the universe, result – if interpreted from the point of view of the CTH - in a decelerated expansion, as required by the Einstein-de Sitter universe.

- Dark matter" could also possibly not exist, because the KZH demands that the "gravitational constant" is time-dependent and becomes larger the further the observed objects are spatially and thus also temporally distant from us.

- Gravitationally bound local systems, e.g. Earth - Moon or Sun - Earth, expand according to the same law as the universe. This explains why Hubble's law also applies with in very small groups of galaxies, as observations show

- The CTH requires that the strongest force (strong nuclear force) and the weakest (gravitational force) at Planck time ($t_p \approx 10^{-43}$seconds after the "big bang") when all forces of nature are supposed to have been united in a single super force, were of equal magnitude and had the same range. According to the KZH, the product of the strength and range of the gravitational force is constant, i.e. independent of time, and is identical to the product of the strength and range of the strong nuclear force.

- At Planck time, the universe had the size of an elementary particle ($R_p = r_E \approx 10^{-15}$ m). This value also corresponds to the range of the strong nuclear force (Yukawa radius) and the Planck length at Planck time.
- The CTH provides a possible explanation for Mach's first and second principles.
- It solves some old problems of the big bang theory in a simple and natural way. The problem of the horizon, flatness, galaxy formation and the age of the world. The inflation theory thus becomes superfluous.
- The CTH provides the theoretical basis for the theory of Earth expansion.
- In Cosmic Time, there was no Big Bang. The universe is infinitely old.
- Unlike other cosmological models, the CTH does not require defined "initial conditions" because there was no beginning.
- The CTH explains why the cosmic expansion is permanently in an unstable state of equilibrium, which is necessary for a long-term flat (Euclidean), evolutionarily developing universe.

KEYWORDS: Cosmic Time Hypothesis; General Theory of Relativity; Dark Matter

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INTRODUCTION

"We have a wealth of data on the nature of the universe, but a comprehensive theory that could explain all these observations is not currently in sight", said Hermann Nicolai many years ago.[1] Scientific discussions also show that cosmology is in trouble today. For[2] "*More and more questions are piling up that almost shake the foundations of cosmology*. Some scientists therefore suspect[3] *Possibly the solution to our questions, our riddles, is also one that cannot be clarified by an experiment by physicists or an observation by astronomers, but by a completely new approach, by another theory.*"

Such a new theory cannot – it seems – be obtained from observational data alone. Perhaps General Relativity (GRT) would have to be thoroughly re-examined, for[4] *"It is not inconceivable that GRT breaks down on a cosmic scale.* "Moreover, as Paul Davies said[5] *"It is still a white spot on the (scientific) map in many areas*", i.e. its explanatory power is far from being fully exhausted.

Above all, a new cosmological model should not contain arbitrary parameters that serve to interpret observations for which the existing theories have no explanation. For whenever a theory has to be "defaced" by the introduction of such ad hoc parameters in order to bring it into line with current observations, one cannot rule out the possibility that the axioms on which it is based may be wrong. Then it is legitimate to look for alternatives.

Stephen Hawking once formulated this situation aptly[6] "*In practice, people are reluctant to give up a theory in which they have invested a lot of time and effort. Usually, therefore, they first question the accuracy of the observations. If that doesn't work, they try to modify the theory on a case-by-case basis so that it fits the observations. Eventually, the theory changes into a crooked and ugly edifice.*" To prevent this, Hawking recommends[7] "*If the modifications to a theory needed to incorporate new observations become too bizarre, it's a sign that a new model is needed.*"

Following Hawking's recommendation, a new cosmological model, the <Cosmic Time Hypothesis> (CTH), is presented here, which cannot only solve many of the existing cosmological problems, but is also simpler and more elegant than the ΛCDM model favoured today.

The CTH is essentially a plea for a cosmic time that, like time in thermodynamics, has a given direction. It thus stands in stark contrast to today's "block universe", a model that regards time as a pure illusion. Asymmetric cosmic time is a logical consequence of general relativity (GRT), if one demands that GRT should apply to the entire universe. From the point of view of this cosmic time, there are serious consequences for our physical world view. It calls into question the fundamental foundations of today's physics by demanding that there can be no iron laws of nature that are valid for all time. Incidentally, this was already suspected by other scientists such as Lee Smolin.[8]: "*Laws are not timeless. Like everything else, they are properties of the present and can evolve over time" and Paul Dirac*[9] *: "At the beginning of time, the laws of nature were probably very different from what they are now". We should therefore consider that the laws of nature change continuously with time, rather than uniformly across space time.*"

CTH derives its legitimacy from the fact that – as already mentioned – it can solve many scientific problems for which there have been no plausible explanations so far. The basis for the CTH is the simplest cosmological model permitted by ART, the Einstein-de Sitter universe.

The Einstein-de Sitter Universe Interpreted

For a long time, the Einstein-de Sitter universe was considered the standard model of cosmology. However, it was later abandoned when measurements of type I a supernovae led to the conclusion that the universe was expanding at an accelerated rate. Another observational result was that the cosmos spans a flat (Euclidean) space, for which the matter known at the time was not sufficient. Instead of trying to reconcile the empirical findings with the Einstein-de Sitter model, the more convenient path was taken and two new parameters were introduced without further ado - dark matter and dark energy – mysterious substances that are ultimately nothing more than place holders for unknown physics. Today, they are an essential part of the current cosmological standard model, the ΛCDM model (Λ = cosmological constant, CDM = Cold Dark Matter). Einstein had already pointed out the right way. For the Einstein-de Sitter universe (Λ = 0), he formulated the equation.[10]

$$\varkappa \varrho/3 - h^2 = 0 \qquad (1)$$

($\varkappa = 8\pi G/c^2$ = coupling constant of Einstein's field equations, G = gravitational constant, c = vacuum speed of light, $p = M/V = 3M/4\pi R^3$ = mean mass density of the universe, R = world radius, $h = 1/ct_H = 1/R$, t_H = Hubble time).

By transforming equation (1) we obtain:

$$GM/Rc^2 = ½ \qquad (2)$$

The problem is: Equation (2) is not compatible with the current state of knowledge, because according to it G, M and c are constant, but R increases with time (in the Einstein-de Sitter universe correspondingly $R \sim t^{2/3}$).

If we assume that Einstein was right, the following consequences arise if we accept the following axioms:

I The speed of light is a universal natural constant.

II Averaged over large distances, space is flat (Ω = 1).

III The universe is homogeneous and isotropic on large scales.

IV The universe is expanding at the speed of light ($\dot{R} = c$)

V The total energy in the universe is constant

From $R \sim t^{2/3}$ (3)

Results in $dR/dt = \dot{R} = c \sim t^{-1/3}$ (4)

This contradicts Axiom I: "The speed of light is a universal natural constant". So the first question to be clarified is: "What do we understand by the term natural constant?".

Answer: Natural constants are physical quantities that can only be determined empirically and cannot be derived from a higher-level theory. The statement c = constant thus means that the measured numerical value of c must always be the same at anyplace and at any time. The problem now is to bring this requirement into agreement with the relationship (4).

As we know, Einstein relativised time twice. In special relativity (dependence of time on relative velocity) and in GRT (dependence of time on gravitational potential). The question now arises whether time does not have to be relativised a third time so that the postulate c = constant is also fulfilled for the relationship (4). The task is therefore to find a time measure that measures the speed of light as a constant quantity at all times, as Einstein recommended.[10] "*One can use the principle of constancy of the vacuum speed of light to complete the definition of time.* "Transferred to the relation (4), the requirement c = constant is fulfilled if one introduces a time τ that changes proportionally to the world radius. An idea, by the way, that Henning Genz already had[11]: *"Why then not go all the way and choose the radius of the universe as the time parameter?"*.

For the Einstein-de Sitter universe, one then obtains forth is cosmic time τ the relation

$$\tau \sim R \sim t^{2/3} \qquad (5)$$

and

$$d\tau/dt \approx \Delta\tau/\Delta t \sim t^{-1/3} \sim \dot{R} \sim c \qquad (6)$$

In fact, as shown in[12,20], pendulum clocks and atomic clocks indicate exactly this cosmic time when they tick according to the laws of KZH. Measured with such clocks, the speed of light is then a constant quantity:

$$c\,(\tau) = dR/d\tau = \text{constant} \qquad (7).$$

The time tract would thus not only depend on the relative velocity (SRT) and the gravitational potential (GRT), but also on time itself (CTH). A comparison of these dependencies is shown in (Figure 1).

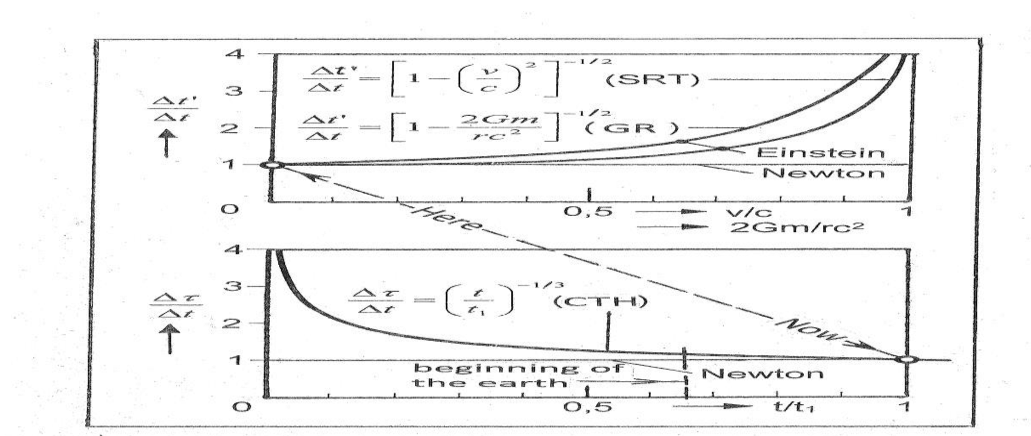

Figure 1: Time measures of SRT, GRT, and CTH

(t_1 = today, $t = t_1 \rightarrow \Delta\tau = \Delta t$, $t = 0 \rightarrow \Delta\tau/\Delta t = \infty$

The GRT thus forces us to introduce the cosmic time τ in order to bring it into agreement with the equation $GM/Rc^2 = ½$ derived from it. In plain language this means: The GRT is time asymmetric! It has a cosmological time arrow, similar to the time arrow in the 2nd law of thermodynamics.
From the relations (2), (3) and (4) one obtains

$$GM = \text{constant} \quad (8)$$

With the assumption that the total energy E in the universe is constant, from E = Mc2 and (4) for the mass of the universe we get

$$M \sim t^{2/3} \sim R \quad (9)$$

Here M means the total gravitationally effective energy existing in the universe ($M = E/c^2$). In addition to the ponderable mass, this also includes the radiation and vacuum energy. All these forms of energy are, as shown in,[12] positive and contained in the energy-momentum tensor of Einstein's field equations.

The other relationships result from (4), (8) and (9).
Gravity constancy:

$$G \sim M^{-1} \sim t^{-2/3} \quad (10)$$

Average mass density of the universe:

$$\varrho \sim R^{-2} \sim t^{-4/3} \quad (11)$$

Mean energy density:

$$\varepsilon = \varrho c^2 \sim t^{-2} \quad (12)$$

One could now object that time-varying "natural constants" ($c \sim t^{-1/3}$, $G \sim t^{-2/3}$) are not compatible with GRT. However, since c and G do not occur solitarily in the field equations, but are connected by the coupling constant $\varkappa = 8\pi G/c^2 = 1.86 \cdot 10^{-26}$ m/kg, there is no contradiction between GRT and CTH.

The Perception of Space and Time

When we project objects in (3-dimensional) space onto a (2-dimensional) plane, such as in a photograph, the further they are from the location of the photograph, the smaller they appear. Objects that are twice as far away appear reduced to about half their size in the photograph (Figure 2). If we look at a very long a venue of trees from the central perspective (Figure 2), very distant trees are focused in the so-called vanishing point.
Since we can move freely in space, we know from experience how large distant objects really are. In time, on the other hand, we are trapped in the "now" and have no way of checking what the passage of time was like outside the

"now". According to the CTH, it should have been shorter in the past than today (Figure 2), i.e. the clocks should have ticked faster compared to today, in the "big bang" even infinitely fast ($\Delta t = 0$). This would mean that the Big Bang singularity would pass into the infinitely distant past.

Figure 2 shows that the time cycle Δt only shortens dramatically very close to the Big Bang singularity, i.e. the universe expanded, in terms of now-time, shortly after the "Big Bang" at an extremely high speed, but not in an inflationary manner as demanded by the inflation theory. From the point of view of cosmic time τ, however, it expanded at the same speed then as it does today, and at a "constant" speed of light ($c(\tau) = dR / d\tau$ = constant). In the present, the time cycle Δt changes only slightly, by only $3{,}5 \cdot 10^{-11}$/year, which is about one millisecond per year. Even 4.6 billion years ago, when our solar system was formed, clocks ran only 14 % faster than today.

Expansion of Flat Space-Time

In the special theory of relativity (SRT), space and time were unified into a 4-dimensional continuum, space-time. Minkowski formulated the relationship

$$dx_1^2 + dx_2^2 + dx_3^2 + dx_4^2 = 0 \qquad (13)$$

(dx_1, dx_2, dx_3 = space coordinates, $dx_4 = i\,c\,dt$ = imaginary time coordinate

$$dx_1^2 + dx_2^2 + dx_3^2 = dr^2 = (c\,dt)^2 \qquad (14)$$

or

$$c = dr/dt \qquad (15)$$

In the Einstein-de Sitter universe ($R \sim r \sim t2/3$, $dr/dt \sim t-1/3$) the following thus applies

$$c = dr/dt \sim t^{-1/3} \qquad (16)$$

This result is identical with the relation (4). However, it is independent of the axiom $\dot{R} = c$. If, at the time, Friedmann's considerations on the concept of time[13] had been associated with 4-dimensional space-time one would have arrived much earlier at a now-time-dependent speed of light, from which the cosmic time τ follows for Euclidean space and the axiom c = constant.

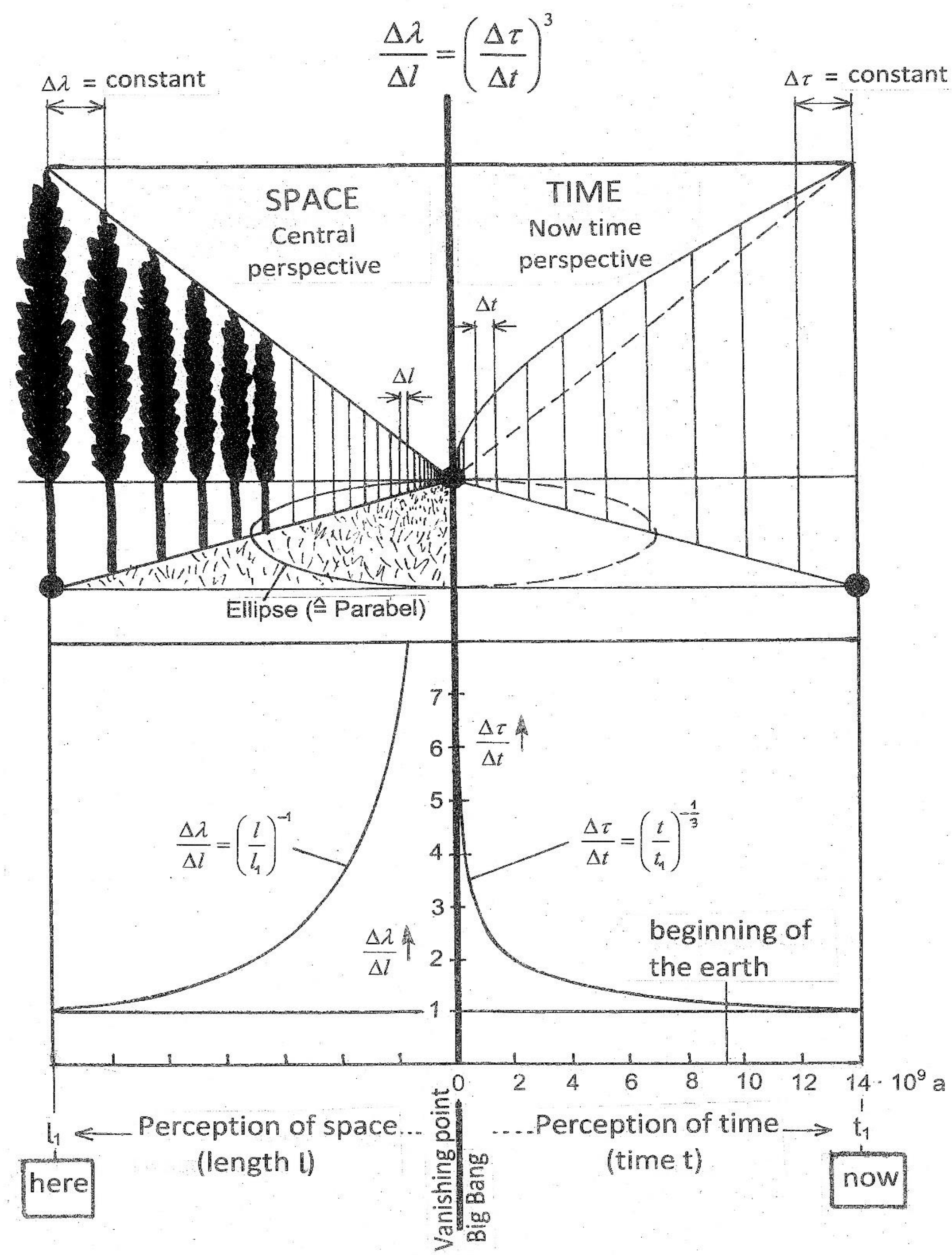

Figure 2: Comparison of space and time perception

For Euclidean (flat) space this gives (see Figure 3)

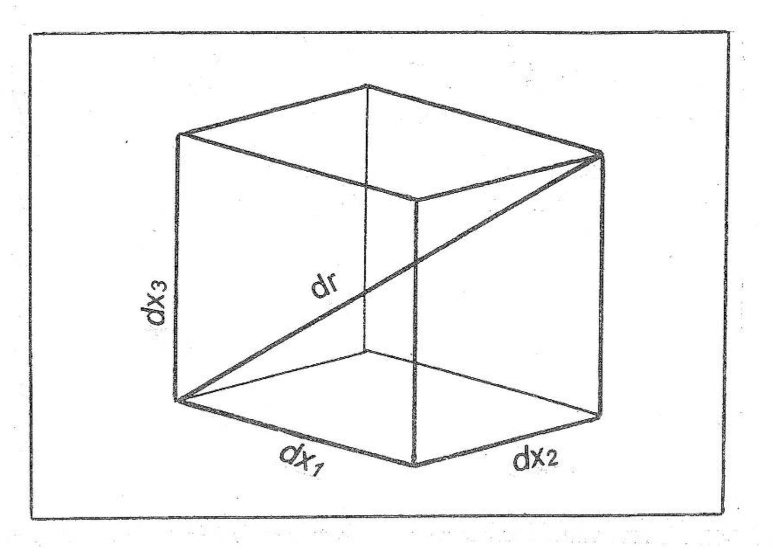

Figure 3: The 4-dimensional space-time continuum in Euclidean space

Limits of Perceptible Reality

Our perception ends in the infinite, i.e. at the singularities, because there time passes infinitely slowly in relation to the "present time". These singular boundaries are (see Figure 1 and Figure 4):

- The outer most boundary of the universe (R), which is moving away from us at the speed of light (SRT).
- The edge (rs) of black holes (GRT)
- The Big Bang (CTH)

Stephan Hawking took a similar view[14]: *"According to the strong version of the cosmic censors hip hypothesis, in a realistic solution, singularities always lie entirely in the future (like the singularities of gravitational collapse) or entirely in the past (like the Big Bang)."*

Since these limits lie in the infinite, the universe has neither beginning nor end.

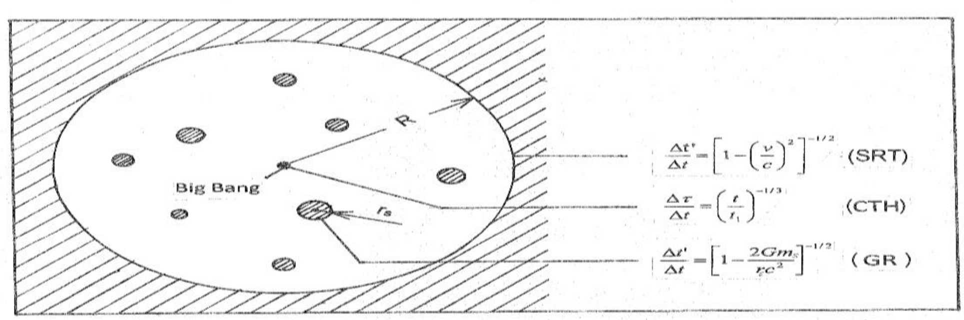

Figure 4: Boundaries of the experiential world

WHAT DOES THE CTH ACHIEVE?

The requirements that are placed on a new theory were summarized by Stephen Hawking as follows[7]

"A model is goodi fit:- is elegant,

- *contains only a few arbitrary elements or elements that can be specifically adapted,*
- *is consistent with and explains existing observations,*
- *makes detailed predictions about future observations that can disprove or falsify the model if they do not turn out to be true."*

To this we would add:

- "explains as many natural phenomena as possible for which existing theories cannot offer a plausible explanation."

As has already been shown and will be explained in detail below, the CTH largely fulfils these requirements. The only problem is its direct empirical verification, because the experiments required for this would have to be carried out at very long intervals in order to be meaningful. If one wanted to verify the CTH, for example, on the temporal change of the gravitational constant G, one would have to prove that the relative decrease of G today is about 7.10^{-11} per year. The currently realized measurement accuracies are far from sufficient for this. The lunar laser experiment says that G would have to change by less than 10^{-6} per year to be undetectable by measurement. That is less accurate by a factor of 10000 than would be necessary! Another way of verifying the CTH is to explain events observed by astronomers or demanded by theorists in the distant past more convincingly than the existing theories can. Some examples of this are presented below.

The Dynamics of Local Structures

Matter in a local gravitational field attracts each other until a stable state of equilibrium is reached.

Example: planets orbiting a central star. Matter in the universe often forms local structures, which - according to current theories – should become increasingly dense over time. However, this is refuted by observation.[15] "*It is now downright absurd that in very small groups of galaxies Hubble's law is observed in the same way (as for the entire universe) even with the same value Ho! This very irritating anomaly defies any accepted description of structure formation."* CTH provides an explanation for this anomaly using the example of planets orbiting the Sun in a stable orbit. Since the gravitational constant decreases with time according to the CTH ($G \sim t^{-2/3}$), the radius r of the planetary orbits does not remain constant, but must slowly increase in order to maintain the state of equilibrium between centrifugal force and gravitational force. The law according to which the orbital enlargement takes place is explained in (Figure 5). The result:

$$r \sim t^{2/3} \qquad (16)$$

The astronomical observations are thus confirmed by the CTH.

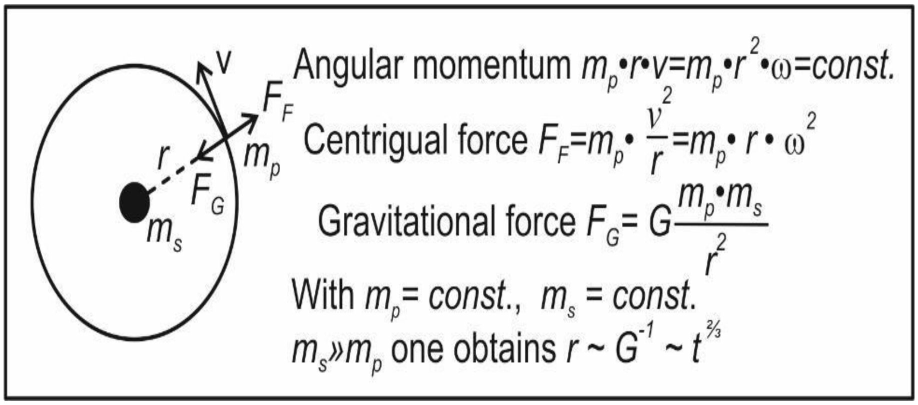

Figure 5: Expanding local structures

The relationship (16) does not violate the current state of knowledge[16] *"In fact, to this day, experts disagree as to whether space within galaxies or even between the planets of our solar system is not also expanding."*

Thus, the Moon could also be moving away from the Earth. According to CTH, that would be about 2,7 cm/year. Measured was 3.8 cm/year The difference is probably due to braking forces caused by the tides. If $G \sim t^{-2/3}$applies, a small expansion should also be observed within individual celestial bodies such as stars and planets. In stars, however, gravitational force and radiation pressure are in equilibrium

$(G \sim c2 \sim t^{-2/3})$. They therefore retain a constant magnitude over a long period of time – until the radiation pressure rapidly decreases towards the end of their lifetime. The situation is different for bodies that are shaped solely by gravitational forces, such as the Earth.

Paul Dirac already had the idea that the gravitational constant should decrease with time. Based on this, Pascual Jordan developed the <theory of Earth expansion> in 1964.[17] It is an alternative to "plate tectonics", which led to fierce controversy among geoscientists.[18] According to the CTH, however, it is not "either - or", but "both and". Both theories are necessary to explain the face of the Earth today.[12]

Dark Energy, Cosmological Constant and Vacuum Energy

The topic has already been treated in detail in[12] and was last published in.[19] Therefore, only a short version is given here. Measurements of supernovae of the SNI a type show that the universe is expanding at an accelerated rate. Dark energy was introduced to explain this. It is also supposed to provide them is sing energy that is necessary for a flat universe ($\Omega = 1$). A synonym for dark energy is the cosmological constant Λ. It represents a constant negative vacuum energy density ε_v, which, as an anti gravitational force, is supposed to cause the accelerated expansion of the universe today.

According to conventional theories, there is a linear relationship between Λ and εv

$$\Lambda = \varepsilon_v \frac{8\pi G}{3c^2} \qquad (17)$$

For the Eistein-de Sitter universe ($\Lambda = 0$, $\varepsilon_v \sim t^{-2}$), this equation is thus irrelevant. The question is what the term vacuum energy density then means. According to the CTH, ε_v is positive and time-dependent, not negative and constant as assumed since. ε_v is part of the total energy density ε of the universe and is contained in the energy-momentum tensor of Einstein's field equations. The relationship[20] applies:

$$\varepsilon_v = 0.75\ \varepsilon \sim t^{-2} \qquad (18).$$

As far as the SNI a measurement results are concerned, one must assume that they are correct, because they have been confirmed by many scientists in the meantime. The only question is: Were the measurement data interpreted correctly? If one evaluates them according to the CTH, one surprisingly obtains completely different, much more plausible results. This will be explained briefly.

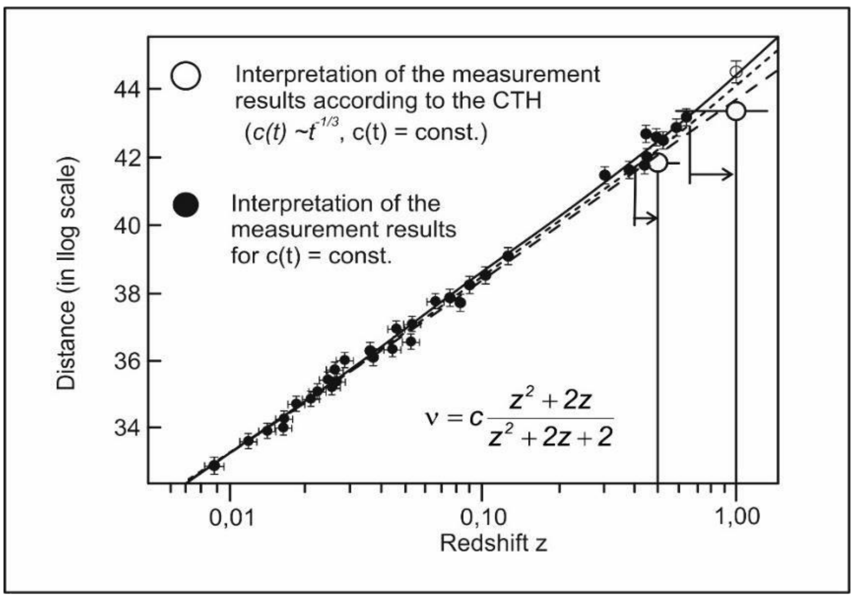

Figure 6: Hubble relationship according to measurement data from SNIa

Hubble's law states that the escape velocity of a galaxy increases in proportion to its distance. The escape velocity of an object is determined by measuring the red shift z of the light it emits light emitted by it. According to the CTH, the speed of light used to be greater than it is today ($c = \dot{R} \sim t^{-1/3}$). Thus, the same red shift results in greater escape velocities v and thus greater distances than according to conventional theory, and the difference becomes greater the further away the celestial body is. (Figure 6) shows the measured data evaluated according to the CTH in comparison with conventional evaluations. An accelerated expansion of the universe is no longer recognizable from this, which also invalidates the main argument for the introduction of "dark energy". The SNIa measurement results are therefore no surprise, but are to be expected after the CTH.

The Enigma of the Cosmological Constant or Vacuum Energy Density

"It remains unsolved to this day and is perhaps the deepest unsolved fundamental problem in physics today".[21]

What is most irritating is that the value for the vacuum energy density calculated according to quantum field theory (QFT) is higher by a huge factor of 10^{122} than it should be according to observations.

How to calculate the vacuum energy density by means of QFT is explained by H. Goenner[22]: *"In the existing quantum field theories, the vacuum energy density usually diverges (ultraviolet divergence), i.e., the integral over all wave numbers k diverges. To avoid infinitely large values, one cuts off the k-space at an energy scale E_x = 10^{19}GeV, i.e. at the Planck scale ($t_p = 10^{-43}$s)."*

According to equation (18), the vacuum energy density at Planck time ($t_p = 5{,}4 \cdot 10^{-44}$s) – quantum field theory cuts off the divergent integral series at this point – compared to today ($t_1 = 4.3 \cdot 10^{-17}$s) yields a ratio value of

$$\mathcal{E}_{vp}/\mathcal{E}_{v1} = (4{,}3 \cdot 10^{17}/5{,}4 \cdot 10^{-44})^2 = 0.6 \cdot 10^{122} \qquad (19)$$

This is an amazing result and it solves one of the biggest problems in modern physics! In summary, the CTH requires a completely new interpretation of the term "vacuum energy":

I. The vacuum energy density is positive and time-dependent ($\varepsilon_v \sim t^{-2}$), not negative and constant, which is the assumption of the current doctrine.

II. The cosmological constant does not exist in reality ($\Lambda = 0$), therefore there is no "dark energy" ($\Omega_\Lambda = 0$).

III. The vacuum energy density is part of the total energy of the universe and is contained in the energy-momentum tensor (T_{ik}) of Einstein's field equations. $\Lambda = 0$ means: the CTH gets by with one free parameter less than the ΛCDM model!

Does Dark Matter Exist?

"In April (2012), the news caused a stir that the European Southern Observatory in Chile had searched the motion of 400 stars around the Sun for signs of dark matter - and found nothing.[23]

Other studies, such as the distribution of dwarf galaxies around our Milky Way, led to the same conclusion.[24] *" ... the distribution of these satellite galaxies of the Milky Way speaks against the existence of dark matter: they lie approximately in one plane, which should be impossible according to common formation models*."

Although there could be something like "dark matter" on larger scales – the observed rotational velocities of stars at the edge of their associated galaxy and the gravitational lensing effect suggest this – some scientists are now considering whether these observations could have other causes, e.g. that the law of gravity must be slightly modified for large distances,[25] *Such that under certain circumstances the gravitational forces are a little stronger than thought. This alternative to standard cosmology is conceptually even simpler than the dark matter hypothesis, which speaks in its favour for reasons of scientific theory.*

And the standard model of particle physics would not have to be supplemented by the particles of dark matter and would continue to be valid. There would no longer be any mass "missing" in galaxies, instead the visible baryonic matter would causes lightly stronger forces."

So at great distances from the solar system, there could be a tiny deviation from Newton's law of gravity.[24] "*From rotation curves of galaxies, an order of magnitude of* 10^{-10} m/s^2*has been derived for this threshold. (For comparison: on the Earth's surface, we experience an acceleration 100 billion times stronger due to the Earth's mass*."

Since when we look at galactic objects we also always look back a bit into the past, we see them in the state they were in as many years ago as they are light years away from us.

According to the CTH, gravity was stronger in the past than it is today ($G \sim t^{-2/3}$). Close objects should therefore – as measurements also prove – hardly provide any indication of "dark matter". However, the greater the distance, the greater the observed deviation from Newton's law of gravity (G = constant) would have to be.

In fact, the further away the objects are from us, the more dark matter is required by astronomical observations. While it is not detectable at all near the Sun, very distant groups of galaxies, such as the Distant Red Core (DRC) consisting of 10 galaxies, require a maximum of dark matter.[26] *"According to our calculations, the halo DRC contains nearly the maximum amount (of dark matter) that is theoretically permissible at this time in the history of the universe."*

This would be a strong indication that a larger gravitational constant in the past ($G \sim t^{-2/3}$) and not Dark Matter could explain the observations.

(Figure 7) shows the dependence of the gravitational constant G on world age t. When the universe was half as old as it is today, it would have to have been larger by a factor of 1.6, for example. The most important measurement method for detecting "dark matter" is the gravitational lensing effect. This measures the deflection of light caused by massive objects that lie between Earth and distant galaxies or galaxy groups. A deviation from G = constant would have to be particularly noticeable. It would therefore have to be checked on the basis of the measurement data whether a gravitational constant that decreases with time ($G \sim t^{2/3}$) could explain the experimental findings. If this were possible, then there would be no dark matter at all.

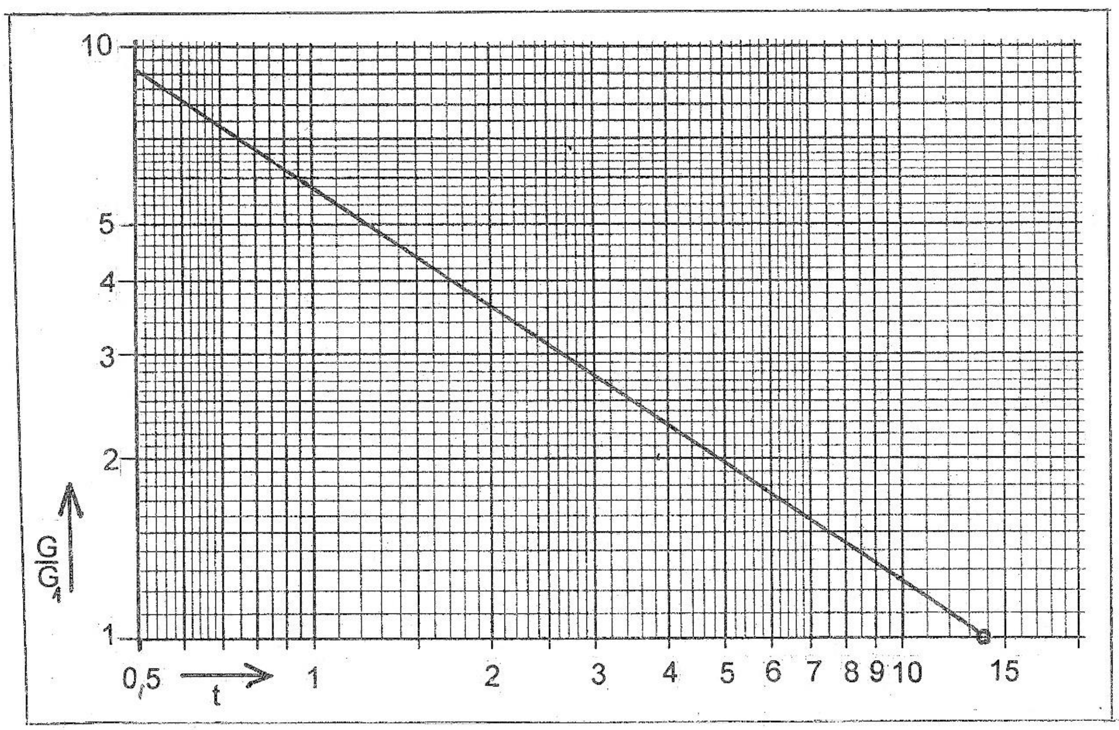

Figure 7: Dependence of the gravitational constant on time

t = world age in billions of years

G1 = present-day gravitational constant

G = time-dependent gravitational constant ($G \sim t^{-2/3}$)

The Unstable Equilibrium of Cosmic Expansion

To date, there is no satisfactory answer to the question why the universe permanently spans a flat (Euclidean) space. Although the inflation theory tries to give an answer to this, it would have to have set the universe flat with the extreme precision of 10^{-50} for it to have evolved as we observe it today. That such a highly unstable state would be maintained for more than 10 billion years contradicts all experience in physics. The universe in its present form should therefore theoretically not exist at all. At the very least, its existence would be extremely improbable if the currently accepted cosmological models were to apply. To this day, no one can explain the astonishingly stable expansion of the universe, which has been balancing on a knife's edge for billions of years, deciding whether it will collapse again or experience a galloping expansion in which neither concentrations of matter, let alone living beings that think about the cosmos, could have evolved.[25] "*In fact, it appears that the universe has been performing this delicate balancing act for 15 billion years, a process that is highly improbable, if not simply impossible.*"

J.D. Barrow also marvels at the fact that the universe, as the latest measurements show, is almost exactly flat.[26]: "*The fact that the expansion, even after tens o f billions of years, still stands irrefutably at the critical threshold between a finite and an infinite future poses all kinds of riddles for us After all, it implies, among other things, almost fantastically improbable preconditions for the initial conditions of the "big bang".*

According to the CTH, this constraint does indeed exist. The time dependence of the expansion velocity ($\dot{R} = c \sim t^{-1/3}$) and the gravitational constant ($G \sim t^{-2/3}$) mean that the smallest deviations from a flat universe do not increase with time as in the inflation-based big bang theory, but the exact opposite takes place: Every deviation from flatness is levelled out again by a law inherent in the evolution of the universe as time progresses.

How the permanent levelling off into the state of equilibrium takes place shall be briefly explained.
According to the CTH, the following applies: $c \sim t^{-1/3}$, $G \sim t^{-2/3}$, G/c^2 = constant.
Case l: Fluctuations cause the universe to expand somewhat faster than
Eq. (2) predicts, i.e. $\dot{R}_{is} > \dot{R}_{soll}$. Because $\dot{R} = c$ and $G \sim c^2$, $G_{ist} > G_{soll}$, which delays the expansion.
Case II: The universe expands slightly slower than Eq. (2) requires, i.e. $\dot{R}_{is} < \dot{R}_{soll}$. Then $G_{ist} < G_{soll}$, which accelerates the expansion.
Seen in this way, the universe can be compared to a tight rope walker who keeps his balance by small changes in his posture. Thus, the universe exists only because the asymmetry of time forces the steady leveling of cosmic expansion into the unstable state of equilibrium.

The Unification of the Strong Nuclear Force with the Gravitational Force

The standard model of elementary particles describes the subatomic world. It contains all the fundamental forces, except for gravitation, which does not seem to fit into the framework. In order to be able to integrate it into the Standard Model, it is expected that experiments at the LHC particle accelerator will generate new particles that will then pave the way for a new theory that unites gravity with the other fundamental forces (strong and weak nuclear force, electromagnetic force).

The <Cosmic Time Hypothesis> (CTH) follows a completely different path. It assumes a time-variable gravitational force, which leads to the fact that at Planck time ($t_p \approx 10^{-43}$) seconds after the Big Bang), this force was exactly as large as the strong nuclear force. This is consistent with super symmetry (SUSY), according to which all natural forces (including the gravitational force) were united in a single super force at Planck time. The link between the gravitational force and the strong nuclear force also suggests itself because there is a special relationship between the two. Brian Green has already pointed this out, namely.[28] *" ...that although the gravitational force and the strong force have very different properties, they have a similar function: Both are necessary for the universe to exhibit* *certain symmetries. The same applies to the weak and electromagnetic force. Their existence is also bound to certain gauge symmetries."*

From relation (10) it follows for the relation between gravitational force FGP at Planck time ($t_p = 5,4 \cdot 10^{-44}$ s) and the gravitational force F_{G1}oftoday ($t_1 = 4,3 \cdot 10^{17}$ s):

$$F_{GP}/F_{G1} = (t_1/t_p)^{2/3} = 0,4 \cdot 10^{41} \quad (20)$$

This result agrees with the value given in the literature as the ratio between strong nuclear force F_s and present-day gravitational force F_{G1}.[29] It thus holds:

$$F_s \approx 10^{41} \cdot F_{G1} \quad (21)$$

and

$$F_s \approx F_{GP} \quad (22)$$

The rangers of the strong nuclear force is about 10^{-15}m,[29] so it is identical to the range of the gravitational force at Planck time (the universe then had a radius of 10^{-15}m,[12] when the first symmetry breaking of the forces of nature took place. This results in:

$$F_s \cdot r_s = F_G \cdot R = \text{constant} \quad (23)$$

Later, the other natural forces also became independent (see Figure 8).

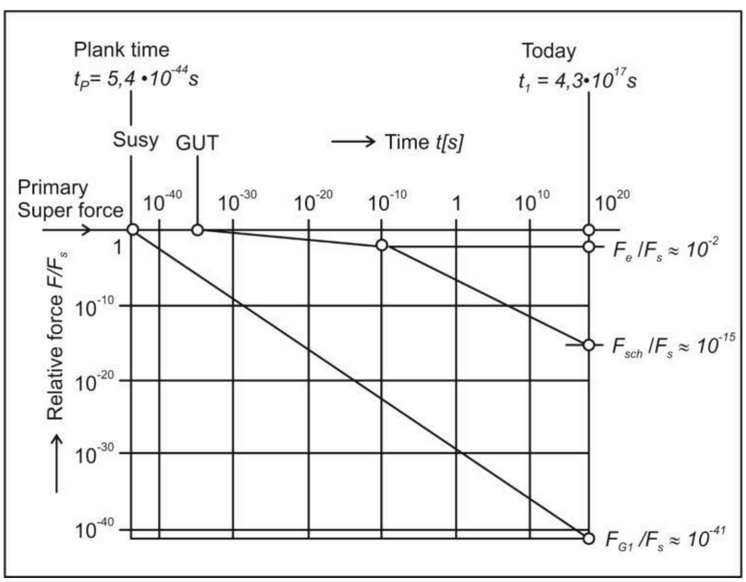

Figure 8: The fundamental forces of nature

(F_s = strong nuclear force, F_{sch}= weak nuclear force, F_e = electromagnetic force, F_G = gravitational force)

It is interesting to note that according to loop quantum cosmology, the gravitational force at the Planck-scale ($l_p \approx 10^{-15}$ m) is said to have had a repulsive effect,[27] which for the strong nuclear force is also Interestingly, according to loop quantum cosmology, the gravitational force at the Planck-applies (see Figure 9). This similarity between the gravitational force and the strong nuclear force[28] suggests that before the first symmetry breaking ($t < 10^{-43}$ s) there was indeed a repulsive super force that could have triggered the expansion of the universe. Here is a quote from B. Geene[28] *"The surprising discovery was made that gravity can be repulsive under very specific conditions, and according to the theory, these very conditions prevailed at the earliest moments of cosmic history. During an interval of time next to which a nanosecond would seem like an eternity, the universe offered conditions in which gravity could exert its repulsive effect so violently that every region of space was driven away from every other with tremendous force. The repulsion of gravity was so violent that it not only identified the bang, but it proved to be bigger – much bigger – than anyone had dreamed."* Such extreme events could possibly also explain the CTH. It requires that the expansion velocity of the universe ($\dot{R} = c$) was a huge factor of 10^{20}greater in Planck times than it is today. In order to produce this enormous expansion speed, the primordial, repulsive super force would indeed have had to have been unimaginably large, which seems quite plausible if one assumes that it had a similar course at that time as the strong nuclear force (Figure 9). In terms of cosmic (real) time τ,[12, 20] however, this expansion process took place much more slowly than from the perspective of today's time t.

Even if these considerations are rather speculative, they could perhaps build a bridge between quantum physics and time.

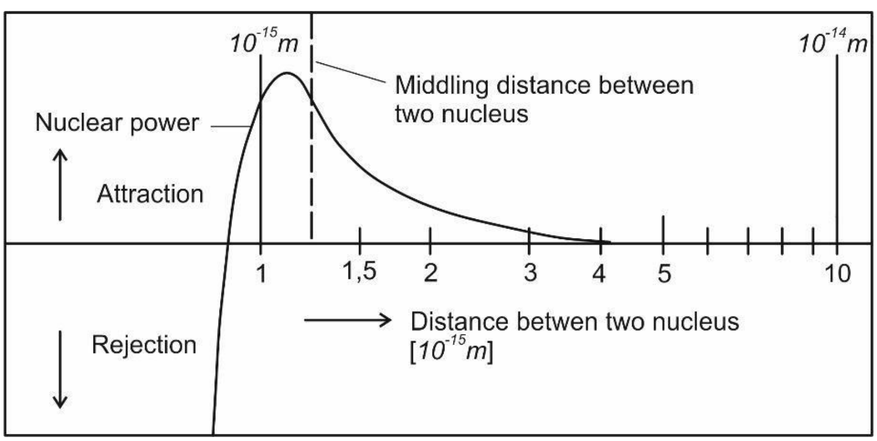

Figure 9: Strength of nuclear forces, depending on the distance of two nucleons from each other (qualitative)[29]

EPILOGUE

To this day, scientists disagree about whether time is real or merely a fiction. In natural science, at any rate, time has been regarded as a pure illusion since Einstein. In cosmology, this is expressed in the so-called "block universe", in

which the history of the universe is regarded as a timeless whole. Julian Barbour also argues for this in his book "The End of Time", in which he tries to prove that time ceases to play a role in the fundamental natural sciences.[30]
The disappearance of time in physics is based on the premise that time is symmetrical, i.e. reversible. In contrast, asymmetric cosmic time has a predetermined direction, i.e. it is not reversible and therefore cannot be eliminated. Such a cosmic time would have the consequence that the laws of nature are not strictly causal. This would be necessary in order to explain the manifold evolutionary development processes that we observe everywhere. They are based on unpredictable spontaneous mutations that are limited by the selection pressure of the environment to a level that is favourable for evolution. There are also fluctuations on a cosmic scale, e.g. deviations from the theoretically required expansion speed of the universe. However, they are kept within limits because (according to the CTH) the universe always settles back into the unstable state of equilibrium that we observe today. Such a time-dependent "dynamic in stability[31] is characteristic of most natural events. That is why we find it difficult to accept a timeless universe. Prigogine also does not believe in a timeless world event.[32] *"Time cannot spring from timelessness. The timeless laws of physics cannot be accepted as a true " reflection" of the fundamental truth of the physical world, because this truth makes us strangers in this world and reduces the manifold of phenomena we observe to a me reappearance."*

Even purely subjectively, we feel that there should be a flow of time. We can even observe it when we look at objects that are moving. Or as John Barrow more aptly puts it,[33,34] *"Time measures the speed at which something happens."*However, we can only perceive the events that happen from the "NOW" perspective. Past events by remembering them "now" or only registering them "now" and future events by imagining them "now". What remains unclear, however, is what the "NOW" means. Does it move through time or does time flow past it? In his book "NOW", Richard A. Muller views time as a flow that constantly creates new "nows" in the expanding universe.

What ultimately matters, however, is that we use a concept of time with which we can describe reality as comprehensively and simply as possible. And this is exactly what a symmetric cosmic time does. If this could be convincingly verified, it would be a brilliant confirmation of GRT, for it does not contradict it in any point, but extends is GRT, because it does not contradict it in any point, but considerably extends its scope.

BRIEF SUMMARY

The basis for the CTH is the Einstein-de Sitter universe derived from Einstein's field equations. In order to preserve the axiom: "The speed of light is a universal natural constant", the asymmetric cosmic time (τ) was introduced. This relativises time - beyond SRT and GRT - a third time.

(Figure 10) shows the development path of the CTH in compressed form. In contrast to many other new theories, cosmic time does not make the description of the physical world more complicated, but simpler. This is because it frees cosmology from unnecessary ballast.

Examples:

- There was no inflationary phase in the early universe. The inflation theory is therefore invalid.

- There is no dark energy ($\Lambda = 0$), but in itsplace a positive, time-dependent vacuum energy density as a component of the total energy density of the universe.
- Possibly, there is also no dark matter because the CTH requires a time-dependent gravitational constant ($G \cdot t^{-2/3}$).

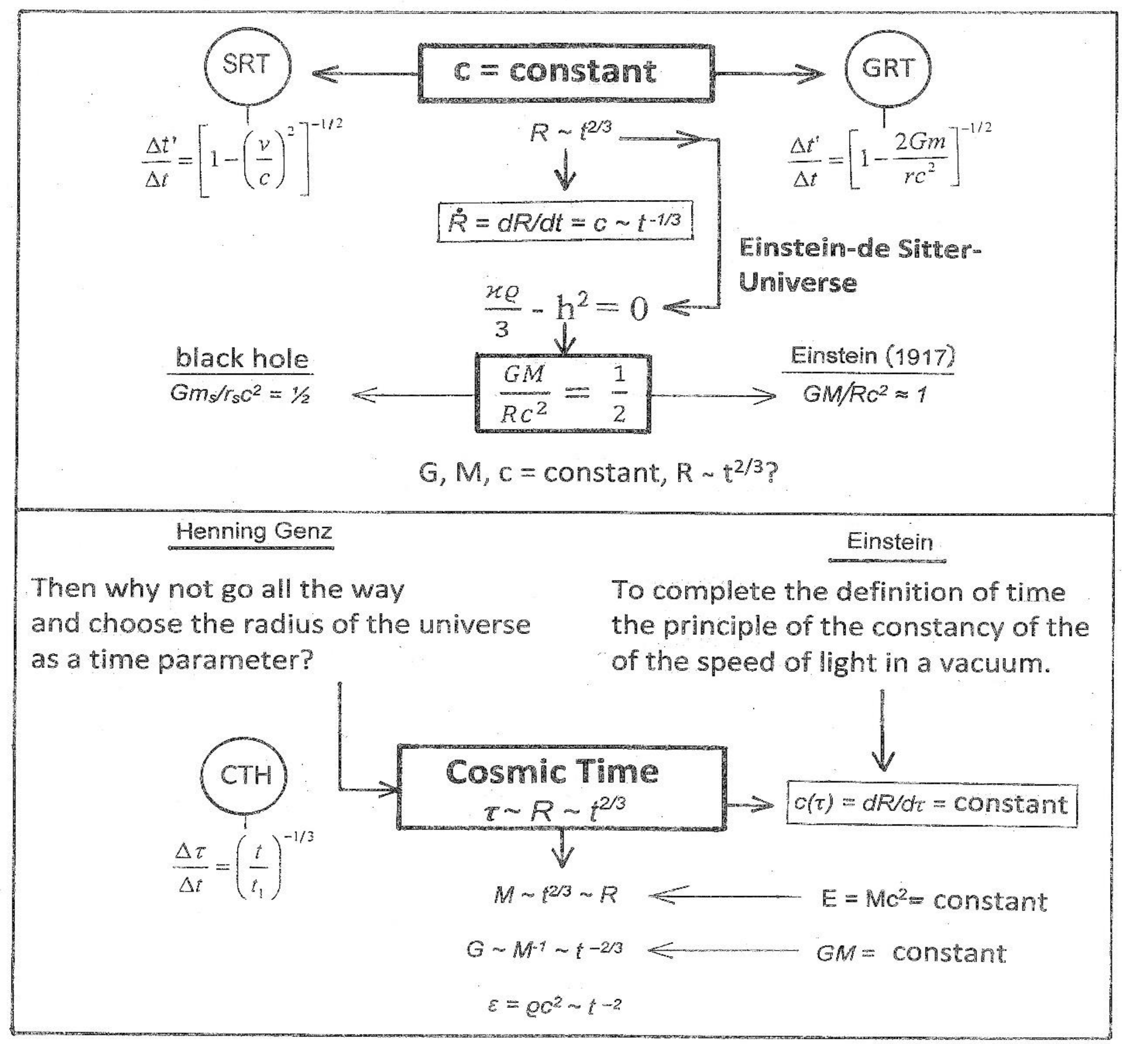

Figure 10: KZH evolutionary path

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