Spacetime of Pseudo-Kasnermetric with shrinking timelike dimension and the Big Rip

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Abstract:

Described is a Pseudo-Kasnermetric of local spacetime with shrinking timelike dimension-coordinate (TLD) as a solution of GRT gravity fieldequation. This metric leads to normal flat Minkowski-spacetime in time intervall of present time but changes with changing of timelike coordinate from a 1-dimensional only timelike spacetime in early universe to a more 3-dimensional pure spatial space in far future with only spacelike coordinates or dimensions (SLD) and shrinking timelike coordinate until it reaches the Planck-time. This whole description leads to the model of a spacetime with permanent shrinking timelike dimension and a prediction of maximal length of spacelike dimernsions through existence of a rip-length.

Key-words:

Pseudo-Kasnermetric; four-spacetime; timelike-coordinate; shrinking dimension; space without time; gravity field-equation; expanding universe; flat Minkoski-spacetime; adaption of Kasner-metric; TLD; timelike dimension; ; time-travel; Big Bang/Big Crunch; Big Rip.

1. Introduction:

A Pseudo-Kasnermetric can be described as a solution of GRT-gravity fieldequation with shrinking timelike coordinate. This model describes an anisotropic universe in empty spacetime, also without matter, it is a vacuum solution. The anisotropy describes only the timelike dimension-coordinate, so its homogenious and isotrop in its three spacelike dimensions but the timelike dimension is shrinking, while the spacelike coordinates expand itself. In the early universe there existed logically only the one timelike dimension, before the SLDs enfold in Big Bang from Planck-length to their today measurable values. In the far future spacetime will be only threedimensional in this model, because the TLD shrinks to Planck-time resp. in multplication with local invariance velocity c to Planck-length. Time is changing into space and wears out itself in this process.

In following, there has to be distinguished between physical and mathematical zeros. The latter can be defined (like a temperature of zero at the Kelvin-scala, which is no physical expression or the „zeropoint-energies“), the further doesn‘t really exist in nature, because there are only measurement values under the range of the measuring instruments or devices which can‘t be supposed to be zero. There is no zero in nature nor are there infinities. These are pure mathematical expressions and idealisations. In this case latter a tear resistance (TR) of spacetime is introduced as a maximal value of existing state coupled with cosmic expansion of real existing universe, not a mathematical construct. This TR exists as well as for spacelike/timelike component- cases but also for the whole four-system with its description of spacetime. Since matter seems only garbage in the history of universe and there is too little of it in cosmos to play any important role, even with dark matter, it can be neglected in the consideration. Matter is just useless and unnecessary waste and garbage in the universe. Matter is only firework, only show. One has to look at the deeper structure of spacetime itself, *on the vacuum-energy structures of gravity field-equation*. And thus also Life is just a small speck of dirt on the wall of the universe. Like matter it is without any matter for evolution of cosmos.

2. Methods/Calculation:

2a. Ordinary Kastner-metric (KM) in pure mathematical description:

Some of the following statements in this paragraph are useful for a real spacetime-description but some are pure nonsense because of inadmissible idealization in pure mathematical spaces. Einstein said: *“This applies in particular to our concepts of time and space, which physicists —forced by facts—had to bring down from the Olympus of the a priori in order to repair them and restore them to a usable state.”* [1.]. Nevertheless, a short introduction into this theme is now made but it may never be forgotten, that real spacetime is either a very viscous liquidor or a dynamic lattice-net and not an idealized Hausdorff-space with defined point differences of zero but with real Planck-length distances between minimal actions or minimal four events in its gravity vacuum [2.]. In this case it is not smooth but as an example, a rough lattice, maybe dynamic. A form of granular liquid or a stretchable network structure in form of a dynamic lattice, maybe between the geodesics. Spacetime is no matter itself but it is an object, it is structured, solidified energy with its own gravity field from Einsteins non-linear field-equations. In this case it underlies some physical laws of structural strength. Spacetime is not only a *mathematical description with mathematical defined zeros and infinities* but it has a sort of physical structure like a maximal tear resistance and has to be treated as such for description of its expansion.

Now some of the pure (but physically wrong) mathematics, which will be corrected later:

The Kasner spacetime [3.] is a cosmological model, which describes an anisotropic expanding universe in one ore more SLDs. It is an exact solution of the Einstein Vacuum field-equations with the Ricci-tensor of $R_{\mu,\nu}(g)=0$ .There is a possibility in choice of the Kasner-exponents $p_1,\ldots,p_d$. If one of these exponents is chosen negative, then there exists a global spacetime singularity in curvature. After choosing a suitable time orientation, the Kasner spacetime can be used as a model for an anisotropic expanding universe without matter. There is a Big Bang or Big Crunch in description of this universe-model with a pure mathematical definition of $t\equiv 0$, which is not physical. There are some only formal working conditions for this model [4.]:

- It is future-one-connected,
- Geodesics, either, are future-complete or hits the singularity,
- It is global hyperbolic,

- There is a spacelike boundary at the singularity,
- In interpretation of mathematics it has divergent spacelike diameter,
- Isometries come from spherical symmetry,
- Interpretation of Space-coordinates t and coordinates of the sphere converge for a timelike curve, and hit the curvature singularity [5.].

All these statements are proven well [6.],[7.]. Shown here are only the following two lemmata:

<u>*Lemma 1;*</u> A Spacetime of a Kasnermetric (M,g) , is a Lorenzian manifold with $Dim(M,g)=d+1$ for $d\geq 3$. The description is that of an anisotropic, expanding universe and it is an exact solution of the Einstein gravity vacuum-equation $R_{\mu,\nu}=0$.

<u>*Proof 1:*</u> The Ricci-curvature of a semi-Riemannian manifold can be defined as the contraction:

$Ric(g)=C_3^1\boldsymbol{R}\in T_2^0(M)$ of the Riemann-curvature tensor $\boldsymbol{R}$. In local coordinates this can be written in form of:

$$R_{i.j}:=\delta_\mu\Gamma^\mu_{i,j}-\delta_j\Gamma^\mu_{i,\mu}+\Gamma^\mu_{\mu,\nu}\Gamma^\nu_{i,j}-\Gamma^\mu_{i,\nu}\cdot\Gamma^\nu_{\mu,j} \quad . \tag{1.}$$

The only terms, which are not zero by calculation, are:

$$R_{0.0}=\left(1-\sum_{j=1}^{d}p^2{}_j-\sum_{j=1}^{d}p_j\right)\cdot t^{-2} \tag{2a.}$$

and

$$R_{i,i}=\left(1-\sum_{j=1}^{d}p_j\right)\cdot p_i\cdot t^{(2\cdot p_i-2)} \tag{2b.}$$

Ergo the two conditions for the Kasner-metric only holds, iff the Ricci-curvature vanishes. Then, the Kasner-metric indeed is a vacuum-solution of Einstein-equations, which means

$$R_{\mu,\nu}=0,\ q.e.d.\bullet \tag{2c.}$$

Therefore a classical, only mathematical described, Kasner-metric is defined as:

$$M=(0;\infty)x\mathbb{R}^d \tag{3a.}$$

with its “smooth” Lorentz-metric of:

$$g=-dt^2+\sum_{i=1}^{d}t^{2\cdot p_i}\cdot dx_i^2 \quad . \tag{3b.}$$

From the proof can be seen, that a KM must fulfill in its exponent-properties the following existence-conditions:

$$\sum_{i=1}^{d} p_i = 1 \wedge \sum_{i=1}^{d} p_i^2 = 1 \quad . \tag{4.}$$

The first equation describes a $d-1$ dimensional hyperplane but the second condition is the standard sphere S^{d-1} . This means, the possible choices of Kasner exponents lie on a sphere of dimension $d-2$ [8.].

Lemma 2: If the choice of exponents is not one of the trivial solution, (when there exists a $k_0 \in \{1, \ldots, d\}$, so that $p_{k_0} = 1$ and all other solutions of p are equal to zero), then there always exists at least one solution with negative Kasner exponent.

Proof 2:
If both conditions of (4.) are combined, there is:

$$1 = (\sum_{1}^{d} p_i)^2 = \sum_{1}^{d} p_i^2 + 2\sum_{1}^{d-1} p_i \sum_{k>i} p_k = 1 + 2\sum_{1}^{d-1} p_i \sum_{k>i} p_k \Leftrightarrow \sum_{1}^{d-1} p_i \sum_{k>i} p_k \equiv 0 , q.e.d. \bullet \tag{5.}$$

Proof 2 shows, that either the solution is a trivial one or there exist at least three Kasner exponents which are non zero and at least one of them, but not all, needs to be negative. Further can be seen from [9.], that for $d=3$ and without loss of generality, if $p_1 < 0$, then $-\frac{1}{3} \leq p_i < 0$.
For the trivial solution, that is $p_1 = 1$, without the loss of generality, the metric takes the form of:

$$g = -dt^2 + t^2 \cdot d x^2{}_1 + \sum_{i=2}^{d} dx^2{}_i \tag{6.}$$

It is easy shown with a conformal coordinate-transformation, that there can derived the Minkowski-metric from g with the assuming of:

$$t^2 \cdot dx^2{}_1 := d\hat{x}^2{}_1 \tag{7a.}$$

and the terms of:

$$\hat{t} = t \cdot \cosh(x_1) \quad \text{and} \quad \hat{x}_1 = t \cdot \sinh(x_1) \tag{7b.}$$

This leads to:

$$\hat{g} = -d\hat{t}^2 + d\hat{x}^2{}_1 + \sum_{i=2}^{d} dx^2{}_i = -dt^2 + \sum_{i=2}^{d} dx^2{}_i \quad . \tag{7c.}$$

The range of $\hat{t}$: $\hat{t} = (0;\infty) \wedge \hat{x}_1 = \mathbb{R}$. (7d.)

That means, that the Kastner-metric with trivial exponents can be embedded isometrically into the open subset $(0;\infty) x \mathbb{R}^d$ of Minkowski-metric $\mathbb{R}_1^{d+1}$ with its common map [10.].

2b. Curvature of classical Kasner-metric:

Assume δ_t a nowhere vanishing, timelike vectorfield, which defines the future direction (Note that δ here never is a variation but only a vectorfield or a derivation in this paper).
Then, the Kasner-metric is a time-oriented, “smooth“, oriented and connected Lorentz-manifold. The curvature of this spacetime is given by the non-vanishing Christoffel-symbols [11.]:

$$\Gamma^{i}_{0i}=\Gamma^{i}_{i0}=\frac{p_i}{t} \tag{8a.}$$

and

$$\Gamma^{0}_{ii}=p_i\cdot t^{2\cdot p_i-1} \quad . \tag{8b.}$$

The Riemann curvature tensor $R\in T^1_3(M)$ then can be calculated in local coordinates in form of:

$$R_{\delta_\kappa\delta_\mu}\delta_\nu=R^{\sigma}_{\kappa\mu\nu} \tag{9a.}$$

with:

$$R^{\sigma}_{\kappa\mu\nu}=\delta_\mu\Gamma^{\sigma}_{\nu\kappa}-\delta_\nu\Gamma^{\sigma}_{\mu\kappa}+\Gamma^{\sigma}_{\mu\rho}\Gamma^{\rho}_{\nu\kappa}-\Gamma^{\sigma}_{\nu\rho}\Gamma^{\rho}_{\mu\kappa} \quad . \tag{9b.}$$

This calculation then leads to the only existing, nonvanishing components of the Riemann curvature -tensor of $(i\neq j)$ [12.]:

$$\begin{aligned} R^{i}_{jij}&=-R^{i}_{jji}=p_i p_j t^{2\cdot p_j-2}\\ R^{i}_{00i}&=-R^{i}_{0i0}=p_i\cdot(p_i-1)\cdot t^{-2}\\ R^{0}_{0i0}&=-R^{0}_{ii0}=p_i\cdot(p_i-1)\cdot t^{2\cdot p_i-2}\end{aligned} \tag{10a. - c.}$$

The first index can be lowered with the metric:

$$R_{\sigma\kappa\mu\nu}=g_{\sigma\rho}R^{\rho}_{\kappa\mu\nu} \quad . \tag{11a.}$$

This leads to the following conditions:

$$R_{0i0i}=-R_{0ii0}=R_{i0i0}=-R_{i00i}=p_i\cdot(1-p_i)\cdot t^{2\cdot p_i-2} \tag{11b.}$$

and

$$R_{ijij}=-R_{ijji}=p_i p_j\cdot t^{2\cdot p_i+2\cdot p_j-2} \quad . \tag{11c.}$$

From these conditions easily can be seen, that the Riemann curvature only vanishes, iff the Kasner exponents are the trivial solutions e.g. $p_i=1\wedge p_j=0$ or vice versa.

If the Kastner metric is not in the trivial case, then there exists at least one negative Kastner-exponent, and the curvature descends with the pure mathematical assumption of $t\rightarrow 0$, which is in fact of physical reality nonsense, because there is only a $t_{Min}=t_{PL}\neq 0$. So there is the fact of a maximal curvature in real spacetime, not in pure mathematical idealization. More to this theme in Chapter three.

The mathematical case develops this: Coordinate invariant curvature scalars are described like the Kretschmann-scalar K [13.]:

$$K:=R_{\sigma\kappa\mu\nu}R^{\sigma\kappa\mu\nu} \tag{12a.}$$

with:

$$R^{\sigma\kappa\mu\nu}=g^{\sigma\alpha}g^{\kappa\beta}g^{\mu\gamma}g^{\nu\delta}R_{\alpha\beta\gamma\delta} \quad . \tag{12b.}$$

This time, the non-vanishing terms are $(i\neq j)$:

$$R^{0i0i}=-R^{0ii0}=R^{i0i0}=-R^{i00i}=p_i\cdot(1-p_i)\cdot t^{-2\cdot p_i-2} \tag{13a.}$$

and

$$R^{ijij}=-R^{ijji}=p_i\,p_j\cdot t^{-2\cdot p_i-2\cdot p_j-2} \quad . \tag{13b.}$$

These conditions lead to description of the Kretschmann-scalar in pure mathematical, idealized description without physical thinking (which is, as mentioned above , pure nonsense) of:

$$K=\frac{4}{t^4}\cdot\left(\sum_{i=1}^{d} p^2{}_i\cdot(1-p_i)^2+\sum_{i=1}^{d}\sum_{j>i} p^2{}_i\,p^2{}_j\right) \quad . \tag{14.}$$

Now, it is easy to see, that the Kretschmann-scalar would blow up to an unphysical value of infinity, if the senseless mathematical operation of $t\rightarrow 0$ is done. In fact of doing real physics, for $t\rightarrow t_{Min}=t_{PL}$ there is a finite maximal, physical curvature iff there is no description of the trivial solutions but with at least one negative exponent. So it is seen, that the Kastner-metric has a form of finite singularity with a physical radius unequal to zero because of its finite size of curvature. This shall be named a „physical singularity“ or „real singularity“ not a mathematical point in an only mathematical defined space.

The volume element of KM can be described over following formula, where $|g|$ is determinant of metric [14.]:

$$\sqrt{-|g|}=t^{p_1,\ldots,p_d}=t \tag{15.}$$

This leads to a spatial volume of $O(t)$, since the spatial volume slices are always proportional to the volume element. For the unphysical case of $t\rightarrow 0$ the Kasner-metric can be interpreted as a classical cosmological model with a Big-Bang singularity or a Big Crunch by reversing the time-orientation. An isotropic expansion or contraction is impossible, because not all the exponents shall have the same, equal value [15.].

If they were all equal, then by contradiction can be assumed, that from the first condition for all $j \in \{1, \ldots, d\}$ there is $p_j = \frac{1}{d}$ .Then the second condition of (4.) can't be satisfied, because $d \geq 3$ and:

$$\sum_{I=1}^{d} p^2{}_i = \frac{1}{d} \neq 1 \quad . \tag{16.}$$

Therefore the Kasner-metric models an anisotropic expanding (or contracting by time shifting) universe without matter [16.].

3. General physical calculation:

3a. Time-involved Pseudo-Kasner-metric:

Set is a quasi-Kasner-metric of the form:

$$ds^2 = \left(\frac{t}{t_0}\right)^{2 \cdot p_i} \cdot \sum_{1}^{d} dx_i{}^2 \tag{17.}$$

This is for the vacuum-field-equations of GRT without matter-tensor:

$$R_{\mu,\nu} - \frac{1}{2} \cdot R \cdot g_{\mu,\nu} + \Lambda \cdot g_{\mu,\nu} = \frac{1}{r^2{}_{PL}} \tag{18.}$$

with

$$\lim_{R_{\mu,\nu} \to R^V_{\mu,\nu}} \left(\chi \cdot T_{\mu,\nu}\right) \to \chi \cdot T^V_{\mu,\nu} = \frac{1}{r^2{}_{PL}} \tag{19.}$$

and Kasner-conditions of:

$$\sum_{1}^{d} p_i = \sum_{1}^{d} p_i^2 = 1 \tag{20a.}$$

Then this conditions lead with $d=4$ in four dimensions to

$$p_1 + p_2 + p_3 + p_4 = 1 = p_1{}^2 + p_2{}^2 + p_3{}^2 + p_4{}^2 \tag{20b.}$$

All four dimensions have to be treated equally because nothing distinguishes one from the other physically than the presign, so the choice for the relations p_i are:

$$p_1 = -\frac{1}{2}; p_2 = p_3 = p_4 = \frac{1}{2} \tag{21.}$$

All four dimensions are equally in their values, only sign changes in linelelement and dimension normation.

This condition then leads to a metric of:

$$ds^2 = g_{\mu,\nu} \cdot dx^{\mu} \cdot dx^{\nu} = -\left(\frac{t}{t_0}\right)^{-1} \cdot c_0 \cdot dt^2 + \left(\frac{t}{t_0}\right)^{1} \cdot \left(\sum_{i=1}^{3} dx^2{}_i\right) \qquad (22.)$$

with the normalization-functions of metric-tensor matrix (and $g^{\mu,\nu}$ resp. changing signs in exponents) of :

$$g_{\mu,\nu} = \begin{pmatrix} -\left(\frac{t}{t_0}\right)^{-1} & c_V & c_V & c_V \\ c_V & \frac{t}{t_0} & c_V & c_V \\ c_V & c_V & \frac{t}{t_0} & c_V \\ c_V & c_V & c_V & \frac{t}{t_0} \end{pmatrix} \qquad (23.)$$

with $c_V := 1 + \frac{4 \cdot \Lambda}{R} = \frac{\chi \cdot T^V}{R} \neq 0$ or $c_V := \frac{\hbar^2 \cdot (R \pm k \cdot \Lambda)}{m_V \cdot T^V} \neq 0; k \in \mathbb{R}$ or something similar, a dimensionless physical vacuum constant of vacuum gravity field.

χ - Einstein gravitational constant,
T^V - Vacuum energy scalar as part of: $T_{\mu,\mu} = T^M + T^V$,
R - invariant Ricci-scalar,
Λ - cosmological constant.

3.b Metric- changing for the three cases:

$$\begin{aligned} &1.\, t \approx t_0; \\ &2.\, t \ll t_0; \\ &3.\, t \gg t_0. \end{aligned} \qquad (24.)$$

1. For case one there is with global time of $t = t_0$ of our presence the local metric of flat Minkowskispace:

$$ds^2 = -c_0 dt^2 + \sum_{i=1}^{3} dx^2{}_i \qquad (25.)$$

2. For case two the metric leads to:

$$\lim_{t \to t_{Min}} \left(-c^2{}_0 \cdot dt^2\right) = -c^2{}_0 t^2{}_{Min} \quad (26a.)$$

and

$$\lim_{t \to t_{Min}} \left(dx^2{}_1 = dx^2{}_2 = dx^2{}_3\right) = r^2{}_{PL} \quad (26b.)$$

also this is leading to the solution for lineelement of:

$$ds^2 = -c^2{}_0 \cdot t^2{}_{Min} + 3r^2{}_{PL} \quad (26c.)$$

near Big Bang, where the TLD enfolded the SLDs.

3. For case three the term leads to:

$$\lim_{t \to t_{Max} = t_{PL}} \left(-c^2{}_0 \cdot dt^2\right) = c^2{}_0 \cdot t^2{}_{PL} \quad (27a.)$$

and

$$\lim_{t \to t_{Max} = t_{PL}} dx_1{}^2 = dx_2{}^2 = dx_3{}^2 = r_{Max} \quad (27b.)$$

which leads to the end-metric of:

$$ds^2 = -c_0 \cdot t^2{}_{PL} + 3 \cdot r^2{}_{Max} \quad (27c.)$$

This is the case of spacelike cosmic expanding, which is in accordance with astronomical observation of experience today for spacelike slices. As well t_{Max} as r_{Max} deal with sizes of tear resistance of the universe.

4. Tear resistence of the universe – the Big Rip

Since real physical spacetime is some form of material, no geometry because of existence of energy in its vacuum state caused by non-linearity of Einstein-field-equations, it has also physical properties like a tear resistance or a tear length resp. breaking length [17.]. Because the Planck length is the smallest possible length, a brittle, not a ductile, tensile strength is assumed here in first order. The deformation of spacetime can therefore be calculated with a constant cross-section, because this means that no transverse contraction and no fracture necking can occur below from Planck-length. Possible other quantum gravity effects may be neglected in this considered context.

The breaking-length or resistance-length L_R of spacetime is then defined as follows:

$$L_R = \frac{\sigma}{\rho \cdot a} \quad , \quad (28.)$$

where σ is the tear resistance of spacetime, ρ is the matter/vacuum-density of spacetime and a is fundamental Planck-acceleration. ρ is mean-density of universe.

This leads with some assumptions of :

$$a := \frac{c_0}{t_{PL}} \quad , \tag{29a.}$$

$$\rho := \frac{M_{Mat} + M_{Vac}}{V_{Uni}} = \rho_{Vac} + \rho_{Mat,c} \quad , \tag{29b.}$$

$$c_0 := \frac{r_{PL}}{t_{PL}} \quad , \tag{29c.}$$

and $$\sigma := \frac{F_{PL}}{A_{PL}} = \frac{M_{PL} \cdot a_{PL}}{r^2{}_{PL}} \quad , \tag{29d.}$$

to the final calculation of:

$$L_R = \frac{\sigma \cdot V_{Uni} \cdot t^2{}_{PL}}{(M_{Mat,c} + M_{Vac}) \cdot r_{PL}} = \frac{\sigma \cdot t_{PL}^2}{(\rho_{Vac} + \rho_{Mat,c}) \cdot r_{PL}} \tag{30.}$$

and at last (but not least) to:

$$L_R = \frac{M_{PL}}{r_{PL}^2 \cdot (\rho_V + \rho_{Mat,c})} \tag{31.}$$

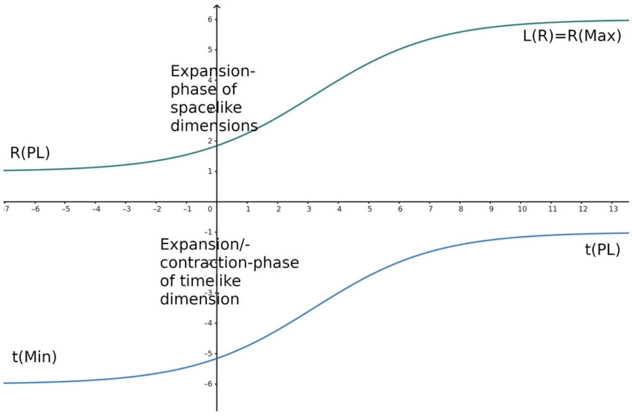
This leads with a mean numerical value of Hubble-constant of $71 \frac{km}{s \cdot Mpc}$ to numerical calculation for resistance-length of universe L_R of :

$$L_R = 1{,}660218804 \cdot 10^{72} LJ = r_{Max} .$$

Also there can be calculated a maximal resistance-time of Pseudo-Kasner-cosmos with cosmological movement of:

$$t_R = \lim_{v \to c} \frac{L_R}{v} = \frac{L_R}{c} = 1{,}660218804 \cdot 10^{72} a = t_{Max} .$$

With slightly different initial values, one arrives at a similar order of magnitude for resistance-length or resistance-time of universe. The graph of *picture 1* below shows the qualitative behaviour of this spacetime:



Picture 1: Qualitative behaviour of Pseudo-Kasner-Spacetime with relative units on the axes. Spacelike dimensions are expanding from Planck-length, while timelike dimension is sign-depended expanding, which means from its norm, shrinking to Planck-time.

Normation of axes:

Abscissa: time t in [a].

Ordinate: space-expansion R in [LJ/pc]

Both axes:

relative terms with Planck-size normed to 1.

5. Summary:

An adaption of Kasner-spacetime can be described in four dimensions with shrinking timelike dimension (TLD) while the spacelike dimensions (SLD) cause expanding universe. Thereby timelike dimension was minimal (which means maximal with negative sign) in the past at Big Bang and was the only, lonely dimension while all three spacelike dimensions hold the state of Planck-Length *and their expansion is caused by this lonely existence of timelike dimension*. Since this TLD causes and holds permanently all SLDs since Big Bang through constant energy transfer to stabilize them, it shrinks itself because it consumes itself in this process. In the far future there will be no timelike dimension anymore in this model without Planck-time resp. Planck-length. This adapted Kasner- Universe will be only threedimensional spacelike then out of the size of Planck-terms in macroscopic state.

6. Conclusion:

Decreasing of TLD evolves encreasing of SLDs like is observed in astronomical descriptions. But the original existence of only one single TLD-coordinate causes basically the enfolding of the spacelike spatial-coordinate dimensions in a wider size. In the far future this spacetime-model shows the universe as pure spacelike structure in three extended dimensions without time resp. timelike dimension except Planck-time. Nothing else remains but $c_0 \cdot t^2{}_{PL} = r^2{}_{PL}$ and three spacelike dimensions without evolving of time. In this model time passes more slowly, thus decreasing the time-like dimension. It wears out while pushing the spatial dimensions. The universe ends when time is used up, i.e., when it stands still, respectively when the state of Planck time is reached. This is also the time of reaching the tear-resistance of universe. May be, with a big rip, then a new cosmological instanton will be born.

7. Discussion:

Since the TLD is shrinking after this simple model of spacetime description and if the model is taken seriously, it may be, that time travel will be easier in the far future than it could be in our present cosmic time because the blocking-conditions for this case of applied physics may be weakening in time with time. Since TLD shrinks in the far future, it may be far easier in this model then to undertake time-travel there than today because the timelike differences of an event may shrink. The increasing timelike coordinate into the past, seen from the future, may cause a form of increasing resistor to get far in the past by time-travel. So time-travel may be restricted to certain epoches far in the future.

A spacetime with shrinking timelike dimension but constant nature-laws can also be interpreted as a spacetime with constant timelike coordinate dimension but changing nature-constants possibly or probably weaking. This is first a sort of a global symmetry contemplation, if both conditions compensate another fully, or a form of local symmetry, if both conditions overlap with a rest different from zero. This idea of changing nature constants is not new and principally measurable, ergo falsifizable as it should in physics.
Dependend from this sort of symmetry there is another form of symmetry, namely a broken Noether-symmetry for continual symmetry-conditions if they exist, because existence of constant timelike dimension preserves a form of global energy-conservation law with timelike invariance of nature laws and so constants, which is not valid in case of changing timelike coordinate-dimension. These both statements seem to be an unsolved contradiction. Since all these descriptions describe a spacetime model without matter it can‘t be the real deal because it is only a vacuum solution without matter influence unless matter is globally seen or interpreted as unimportant for evolution of universe but vacuum tensor-term $g_{i,k} \cdot \Lambda$ of dark energy or cosmological constant would dominate this situation [3.]. Also may be, that time travel gets more difficult in the far future, so there will be no timetravel at all.

8. Acknowledgements:

Many thanks to Shakespeare in Hamlet [18.]: *“The time is out of joint … that ever I was born, to set it right“*.

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10. Verification: This paper is written without help of a chatbot like Chat-GP4 or other artificial tools. It is purely human work.

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