# Problems of single-bang cosmology from the perspective of the mathematically simplest alternative based on Einstein's equations

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## ABSTRACT

The simplest conceivable cosmological ansatz based on Einstein's equations leads to a stationary-universe model (SUM). As a generalization of special relativity its line element is deduced from two postulates. With values of redshift statistically independent of time, a significant Hubble constant is proved in contrast to the conventional Hubble parameter. The model requires a negative gravitational dark pressure of $-1/3$ the critical density. Unknown limitations of proper length and time are derived which cause a struggle of local SRT (representing quantum mechanics) against universal GRT (representing gravitation). With no need for 'dark energy', SUM explains the SNe-Ia data straightforwardly on universal scales $z > 0.1$. A corresponding homogeneous part of non-lensing dark matter would fill the gap to critical density. This suggests a mathematical solution for a perfect black-body background composed of redshifted microwave radiation emitted within the non-expanding universe. Given the law of entropy restricted to evolutionary processes outside 'local-bangs', the model is understood to describe a 'chaotic' post-inflation background, embedding multiverse cosmoses therein. While the ΛCDM cosmology is theoretically founded on an unprovable single-bang origin of the entire universe – supposedly followed by an ad-hoc invented temporary phase of inflation – several high precision measurements of the Cosmic Microwave Background (CMB) raise serious doubts (e.g. a giant cold spot, low-multipole alignments, a reported 'dark flow', two different values for the Hubble 'constant' $H_0$, recently a Sunyaev-Zeldovich cluster count prediction mismatch in the PLANCK 2015 data). Now with a mathematically consistent option on hand it seems necessary to reconsider Lemaître's expanding space conception once more, which had been developed when little or nothing was known about formation, evolution and explosion of stars, quasars (QSOs), hypernovae (SLSNs), gamma-ray bursts (GRBs), supermassive objects (SMOs), active galactic nuclei (AGNi), or Lyman-α blobs. Therefore the hypotheses underlying today's numerically utmost successful Cosmological Concordance Model (CCM) should stand another review, this time in comparison with the new alternative SUM as an unexpected reference model of unique mathematical simplicity. It is no longer possible to take the sheer existence of a black-body microwave background as evidence for a hypothetical big-bang origin of the universe.

*Key words:* galaxies: distances and redshifts; cosmology: cosmic background radiation, dark energy, dark matter, observations

## 1 INTRODUCTION

Undoubtedly there has been an origin of our evolutionary cosmos billions of years ago. It is obvious, however, that a theory which once has arisen from the axiomatic presupposition of no preferred frame cannot arrive with one universal CMB restframe without a hidden logical break. Since such a break is not in Einstein's equations, a misunderstanding may be in their historic interpretation usually referred to as 'relativity theory' (RT).

In contrast to its mathematical apparatus, Einstein's geometric conception of GRT (quasi-dogmatic after 1921) implies a contradiction to its own presuppositions because: any valid conclusion that real space and time might be curved, would need rigid unit sticks and non-affectable clocks to make it a physically testable statement. In fact, however, just his own SRT proves the impossibility of rigid bodies and non-affectable clocks, as can be seen from Ehrenfest's paradox most convincingly. Therefore, either GRT would prove a curvature of space and time under the unrealistic presupposition of fictive 'ideal' rods and fictive 'ideal' clocks, which are not available in nature though, or – in

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accordance with [Poincaré 1902] or old ideas of FitzGerald and Lorentz – non-Euclidean geometry proves real unit sticks and real clocks to be systematically influenced by gravitation and universal motion without any need for a material curvature of space and time (s, Appendix C.3.2).

Besides those physicists who believe that the entire universe had originated together with space and time from one singular 'big bang' out of nothing, there is an increasing number of others preferring alternatives. A 'multiverse', however, is just another word for actually one universe with multiple cosmoses from 'local bangs'. In contrast, any 'parallel-universes' if never causally connected, would physically not exist. The actual entirety will be the one and only universe again.

To distinguish our cosmos from a pre-existing background – allowing for other local 'cosmoses' as well – only this all-embracing background may be named universe. Unlike the word *cosmos*, initially meaning order of our world, the word *universe* means all of all worlds.

The question of an eternal universe behind our evolutionary cosmos leads immediately to the idea of stationarity, though any such attempt seemed blocked since the failure of the outdated Steady-state Theory (SST). That theory, however, did not really describe a steady state because its individual redshift parameters – together with observable quantities depending on $z$ – are functions of time (there would be no need to mention this aspect if not for sake of clarity in the sense of a dissociation from SUM now).

Though of unique mathematical simplicity, the new SUM line element based on both general and special relativity theory has not been taken seriously thus far to stand for a stationary background. A reason may be that it reveals this feature most clearly in *universal* coordinates instead of those in an FLRW form (developed in general by Friedman(n) [1922/24], Lemaître [1927/31], Robertson [1935/36], Walker [1936]).

Since nature cannot be completely described by one all embracing theory chosen from a plenty of equally founded alternatives, some more remarks on the SUM concept, its origin and related earlier attempts are given in Appendix C.4 at the end of this paper. Before providing a convenient access to the question of an alternative Sunyaev-Zeldovich effect possibly making a testable difference, a brief self-contained SUM presentation is given at first. The remaining part of the paper is organized as follows:

Instead of the outdated 'Steady-state Theory' the stationary-universe model SUM [Ostermann 2014] (hereafter quoted as SUM14) is a completely different alternative to the Cosmological Concordance Model (CCM), the latter commonly accepted as standard cosmology today. Intrinsic limitations of proper length and time are derived, implying a struggle of local Special Relativity Theory (SRT, representing quantum mechanics) and universal General Relativity Theory (GRT, representing gravitation). This causes a stationary background universe to be anything but static.

Using one macroscopic constant $H$ in addition to $c$ and $G$ only, the model describes a background free of coincidences or universal horizons. Even if only for the sake of comparability, it seems appropriate to make use of this uncomplicated approach which allows an unbiased systematic classification of observational data. Deduced from two postulates, the SUM is predestined as a reference model. It gives the chance to address in particular twelve fundamental problems of big-bang cosmology in mutual relation as well as their possible solutions.

The fact that there is no other mathematical alternative than that of SUM to the CMB as an assumed relic radiation from a 'big bang', finally demands a thorough investigation without presupposition of any ΛCDM priors. At first glance, regarding a corresponding SUM frequency shift, it seems easy to decide between two different versions of the Sunyaev Zeldovich (SZ) effect. On the other hand, not even the nature of the CMB anisotropies is definitely clear, which may disturb or effectively re-shift a SZ signal according to the tentative ansatz for dark matter radiation.

In the framework of SUM, the critical energy density $\varepsilon_c \equiv 3H^2/(\kappa_E c^2)$ is a real constant (where $\kappa_E \equiv 8\pi G/c^4$). Using the Landau & Lifschitz [1992] notation, the signature of the GRT fundamental tensor $g_{ik}$ is always assigned according to $\eta_{ik} = (+1,-1,-1,-1)$ of SRT. Latin indices $i, k, l$ ... = 0, 1, 2, 3 represent four-dimensional quantities (Greek indices $\alpha, \beta$ ... = 1, 2, 3 spatial quantities only). As usual, all symbols are explained at first occurrence. If not otherwise stated, a bar indicates averaging over space.

Throughout this paper 'stationarity' means rather an ongoing process than a 'steady state'. The term 'single-bang' stands for 'big-bang with singular origin of space and time'.

## 2 RELATIVISTIC DEDUCTION OF A STATIONARY COSMOLOGY BASED ON EINSTEIN'S EQUATIONS

Given there has been something where a big-bang origin of our cosmos took place: What is the line element describing the energy density and pressure of such a pre-existing universal background ('tohu va bohu')?

Since evolution affects our own cosmos from a joint beginning, it is necessary to distinguish cosmos from universe again. If stationary the last, it is including all that is, was, and will be. On the other hand, our cosmos may stand for the largest structure of conjoint local origin surrounding at least the solar system. Considering the difference between cosmos and universe and regarding horizon problems or coincidences unacceptable for the latter, one will find the solution for a stationary relativistic cosmology without unnecessary ultra-large scale peculiarities.

While no physical theory of the universe can be based as of ultimate certainty, the intention of this paper is actually to formulate the basics of the stationary-universe model (SUM) just as concisely and precisely as possible. Therefore, in spite of the fact that several relations below may be mathematically well-known, they are derived explicitly in the new context to make it a self-contained presentation.

The idea leading to SUM, as the only arguable solution of Einstein's original equations without cosmological constant, is that no universal horizons must limit physical reality. While beyond local applicability any 'proper' SRT concepts will prove overstrained in conventional GRT.

### 2.1 The SUM line element from two postulates

Two postulates are used to deduce a cosmological solution of general relativity [Ostermann 2004, 2008b (quoted as RKQ08), 2012a/b]. Its redshift parameters $z$ will turn out to be independent of time. – The postulates are:

*Postulate I:* The universe is stationary, homogeneous, and isotropic, though only on scales large enough.

*Postulate II:* Except for deviations caused by local inhomogeneities the universal coordinate speed of light $c^*$ would equal the natural constant $c$.

Obviously, the first postulate is equivalent to what has been called the perfect cosmological principle in the SST framework, while the second postulate is implying spatial flatness. Together they determine the line element of the stationary universe model

$$d\sigma^{*2}_{\mathrm{SUM}} = \zeta^{*2}_{\mathrm{SUM}} \left\{ c^2 dt^{*2} - dl^{*2} \right\}, \tag{1}$$

where the Euclidean $dl^{*2}$ stands for $dx^{*2} + dy^{*2} + dz^{*2}$ or equivalent forms, and an asterisk '*' always means *universal* quantities. Here these are 'conformal' time $t^*$ – where $t^* = 0$ may stand for today – and 'comoving' distance $l^*$ (or 'comoving' space $\vec{r}^*$). It is of importance that all system coordinates of general relativity can be understood as representatives of a quasi-Newtonian mathematical space and time [Ostermann 2002, 2003], which may be found by arbitrary coordinate transformations from the universal frame, the latter respectively used and spatially determined according to the SUM line element (s. also Appendix B).

Evidently (1) is the simplest conceivable extension leading from special to general relativity theory, which is accounting for a non-empty homogeneous and isotropic universe. The constant universal (coordinate) speed of light

$$c^* \equiv \frac{dl^*}{dt^*} = c \ , \tag{2}$$

resulting from $d\sigma^*_{\mathrm{SUM}} = 0$, would not be given in any form other than (1), which in contrast to the overstrained FLRW form turns out to be of unexpected physical relevance. In addition, dealing with universal distances, the assignment $c^* = c$ is most convenient for a complete mathematical treatment. With the stationary time scalar

$$\zeta^*_{\mathrm{SUM}} = e^{Ht^*} \tag{3}$$

the SUM line element is fixed uniquely now, where $H$ is a macroscopic constant. In contrast to other 'conformal' line elements, the difference is made in that the assignment (3) excludes any 'horizon' of the background universe.

Finally the stationary universal line element (1), (3) may be written as

$$\mathrm{d}\sigma^*_{\mathrm{SUM}} \;=\; \mathrm{e}^{Ht^*}\,\mathrm{d}\sigma^*_{\mathrm{SRT}}\;. \tag{4}$$

Here, however, the expression $\mathrm{d}\sigma^*_{\mathrm{SRT}}$ is different from the usual line element $\mathrm{d}\sigma_{\mathrm{SRT}}$ of special relativity in that the elements of local proper time and length ($\mathrm{d}t_{\mathrm{SRT}}$, $\mathrm{d}l_{\mathrm{SRT}}$) have to be replaced by elements of universal coordinates ($\mathrm{d}t^*$, $\mathrm{d}l^*$). In contrast to the first ones, the latter are not directly displayed by atomic clocks or spectral rods except within limited local regions of space and time. In particular the line element (4) shows the obvious transition from SRT to SUM as a key to the new cosmological model.

Because of the exponential time scalar $\zeta^*_{\mathrm{SUM}} = \mathrm{e}^{Ht^*}$, all relative temporal changes depend on differences $\Delta t^* = t^* - t_{\mathrm{R}}^*$ solely, where $t_{\mathrm{R}}^*$ is a respective reference point of universal time. Therefore no special fixation of that time scale is preferred. This fundamental feature is what allows to set $t_{\mathrm{R}}^* = 0$ for arbitrary complexes of observation.

If one had started without explicitly using the above postulates but axiomatically placing (4) as evidently the most natural ansatz for a cosmological line element of GRT with a non vanishing Einstein tensor, one would have directly presupposed SRT as respective temporary approximation in the neighbourhood of any arbitrarily chosen reference point of universal time.

### 2.2 Motion of free particles in the background universe

It is necessary to verify the basic assumption that the stationary line element (4) is compatible with a constant average distribution of matter and energy. Therefore, the relativistic equations of motion will be solved here for free particles (with coordinates $X^{*i}$ and velocities $U^{*i}$) in the gravitational background field. The result confirms an ultra-large scale universe statistically at rest. The solution is deduced from

$$\delta\!\int\!\mathrm{d}\sigma^*_{\mathrm{SUM}} \;=\; 0\,, \tag{5}$$

which action principle is called Einstein's 'geodesic' law. The equations of gravitational motion resulting from (5) are directly associated to Einstein's equivalence principle. In addition, as is well-known, the derivation from the phenomenological kinetic energy-momentum tensor

$$\mathbf{K}^{*k}_{\mathrm{N}\,i} \;=\; \boldsymbol{\mu}^*_{\mathrm{N}}c^2U^*_iU^{*k}\,, \tag{6}$$

where the individual index 'N' may refer to a corresponding number density $n$, applies to the motion of any particle in the gravitational field given by all others. Bold non-italic symbols like $\mathbf{K}_{\mathrm{N}}{}^{*}{}_{i}^{k} \equiv \sqrt{g^*}\,K_{\mathrm{N}}{}^{*}{}_{i}^{k}$ or $\boldsymbol{\mu}_{\mathrm{N}}^* \equiv \sqrt{g^*}\mu_{\mathrm{N}}^*$ always include the square root of the negative determinant of the fundamental tensor as a prefixed factor, where $\sqrt{g^*_{\mathrm{SUM}}} = \mathrm{e}^{4Ht^*}$. Since here $E_i^k = \kappa_{\mathrm{E}}K_i^k$, the contracted Bianchi identities $E^*{}_{i;k}^{k} \equiv 0$ yield

$$\partial^*_k\mathbf{K}^{*k}_{\mathrm{N}\,i} \;=\; \tfrac{1}{2}\mathbf{K}^{*kl}_{\mathrm{N}}\,\partial^*_i\,g^{*\mathrm{SUM}}_{kl}\,, \tag{7}$$

where $\partial_i^*$ stands for $\partial/\partial X^{*i}$. This equation obviously results in the explicit form

$$\frac{\mathrm{d}U^*_i}{\mathrm{d}\sigma^*_{\mathrm{SUM}}} \;=\; \tfrac{1}{2}U^{*k}U^{*l}\,\partial^*_i\,g^{*\mathrm{SUM}}_{kl}\,, \tag{8}$$

if a conservation of rest mass according to the continuity equation

$$\partial^*_k\!\left(\boldsymbol{\mu}^*_{\mathrm{N}}c^2U^{*k}\right) = 0\,, \tag{9}$$

is fulfilled. Except for collision processes, this applies to the motion of test particles in any external field.

Actually, the variation of (5) with respect to the stationary universal line element (4) yields as solutions of (8) the temporal component of the universal four-velocity $U^{*i}$

$$U^{*0} \;\equiv\; \frac{c\,\mathrm{d}t^*}{\mathrm{d}\sigma^*_{\mathrm{SUM}}} \;=\; \mathrm{e}^{-Ht^*}\sqrt{1+U^{*2}_{(0)}\,\mathrm{e}^{-2Ht^*}}\,, \tag{10}$$

and the spatial components

$$U^{*\alpha} \;\equiv\; \frac{\mathrm{d}X^{*\alpha}}{\mathrm{d}\sigma^*_{\mathrm{SUM}}} \;=\; U^{*\alpha}_{(0)}\,\mathrm{e}^{-2Ht^*}\,, \tag{11}$$

where $U^{*2}_{(0)} \equiv \sum[U^{*\alpha}_{(0)}]^2$ (here $\alpha = 1, 2, 3$). Obviously the integration constants $U^{*\alpha}_{(0)}$ are the initial values of the spatial components at time $t^* = 0$. From this simple calculation the components of the ordinary spatial velocity referring to universal coordinates are $V^{*\alpha} \equiv \mathrm{d}X^{*\alpha}/\mathrm{d}t^*$. Corresponding velocities of free objects, given by

$$\frac{V^{*\alpha}}{c} \;\equiv\; \frac{U^{*\alpha}}{U^{*0}} \;=\; \frac{U^{*\alpha}_{(0)}\,\mathrm{e}^{-Ht^*}}{\sqrt{1+U^{*2}_{(0)}\,\mathrm{e}^{-2Ht^*}}}\,, \tag{12}$$

which in case of massive particles may be regarded as deviations from the state of statistical rest, will obviously decrease with time.

It has to be pointed out that the 4-velocities $U^{*i} = U^{*i}(X^{*i})$ are related to discrete cosmic objects like galaxies or clusters in contrast to $u^{*i} = u^{*i}(x^{*i})$ of an idealized medium like a perfect fluid. The transition should occur by spatial integration of the respective densities, which would apply as δ-functions where necessary.

Only for zero-rest-mass particles like photons where, because of $\mathrm{d}\sigma^*_{\mathrm{SUM}} \to 0$, relation (11) implies $U^{*\alpha}_{(0)} \to \infty$, a constant velocity $|V^{*\alpha}| = c$ results for the universal speed of light directly. On the other hand, for all particles of non-vanishing rest masses this apparently means a deceleration with respect to universal coordinates. Therefore even in intergalactic space a freely falling inertial frame would not keep on moving uniformly with respect to these coordinates. This again implies that there is no physical situation where SRT can be valid otherwise than locally, and thus approximately only.

In any case the result (12) supports the feature of galaxies statistically at rest in universal Euclidean space. This even applies to long-term averages of peculiar motions like that of objects bound in clusters. The special solution describing this situation is

$$\overline{V}^{*\alpha} = 0\,, \tag{13}$$

where – as an exception – a bar means averaging over time. Accordingly, in the SUM framework there is no need for the otherwise established concept of 'expansion', unnecessarily presupposing the universal coordinate frame to be 'comoving'.

The results (10), (13) then also show one non-vanishing component of the mean four-velocity $\overline{U}^{*i} = (\overline{U}^{*0}, 0,0,0)$, which is

$$\overline{U}^{*0} = \mathrm{e}^{-Ht^*} = \frac{1}{\overline{U}^{*}_{0}}\,, \tag{14}$$

implying a universal accelerating time rate of atomic clocks at rest. Evaluating (11), (12) completely, the universal four-velocity $U^{*i}$ may be written in a form analogous to that of SRT at last

$$\left(U^{*0}, U^{*\alpha}\right) \equiv \frac{\left(1, \dfrac{V^{*\alpha}}{c}\right)}{\sqrt{1-\dfrac{V^{*2}}{c^2}}}\,\mathrm{e}^{-Ht^*}\,, \tag{15}$$

where in $V^{*2} \equiv \sum[V^{*\alpha}]^2$ the summation has to be carried out for $\alpha = 1, 2, 3$ again. Relation (15) is different from the SRT assignment, though formally only by multiplication of the reciprocal time scalar $\mathrm{e}^{-Ht^*}$, while according to (12) $V^{*\alpha}$ is not constant in general. The result (15) proves the consistency of the relations above, since it may be alternatively derived using the definitions of 4-velocity $U^{*i} \equiv \mathrm{d}X^{*i}/\mathrm{d}\sigma^*$ and that of ordinary velocity $V^{*\alpha} \equiv \mathrm{d}X^{*\alpha}/\mathrm{d}t^*$ directly.

How an object leaving a Schwarzschild region may turn continuously to the universal motion as derived here is discussed elsewhere [SUM14/2.11] together with a corresponding modification of Galileo's law of inertia. There by transformation to quasi-proper coordinates it is shown that

$$V_{\mathrm{local}} \approx V^{*}_{(0)}\left\{1 - 2\,H^2 t^2\,\frac{V^{*2}_{(0)}}{c^2}\right\}, \tag{16}$$

meaning an approximately constant velocity $V^{*\alpha}_{(0)}$ with respect to *universal* coordinates. This ensures the *local* validity of the law of inertial motion. In particular with respect to an atomic clock at rest passed by any test particle, the modified law of inertia seems kept only piecewise (what is another special aspect of the self-restoring validity of local SRT).

Now, given the stationary line element (4), relation (9) yields in case of free particles at rest

$$\mu^{*}_{\mathrm{N}} = \mu^{*const}_{\mathrm{N}}\,\mathrm{e}^{-3Ht^*}\,, \tag{17}$$

where evidently

$$\mu^{*const}_{\mathrm{N}} = \frac{\mathrm{d}m_{\mathrm{N}}}{\mathrm{d}V^*} \tag{18}$$

Accordingly the rest mass $\delta m_{\mathrm{N}}$ of such a 'particle' is constant, whether taking it from the universal volume $\delta V^*$ or from the local proper volume $\delta V = \delta V^*\,\mathrm{e}^{3Ht^*}$ due to

$$\delta m^{const}_{\mathrm{N}} = \mu^{*const}_{\mathrm{N}}\,\delta V^* = \mu^{*}_{\mathrm{N}}\,\delta V\,, \tag{19}$$

The result of constant mean rest masses is in accordance with the stationarity of the universal matter-energy distribution. Though with regard to an energy exchange by radiation or collision processes, individual universal objects would not obey a rest mass conservation law, there seems to be an overall statistical equilibrium (s. Section 5.3 in addition).

In any case, since the statistically averaged number density of 'particles' is presupposed independent of time with respect to universal (allegedly 'comoving') coordinates, now together with the constant rest masses stated here, also the mean SUM matter density has to be regarded independent of time.

### 2.3 Stationary energy density and a negative gravitational pressure

The exact contravariant Einstein tensor density resulting from the stationary universal line element is

$$\mathbf{E}^{*ik} = \frac{3H^2}{c^2}\,\mathrm{diag}\left(1, -\tfrac{1}{3}, -\tfrac{1}{3} -\tfrac{1}{3}\right), \tag{20}$$

which in spite of the time scalar $\mathrm{e}^{Ht^*}$ in (4) is independent of time. Thus Einstein's equations may be written in an obviously consistent local SRT form

$$E^{*}_{ik} = \begin{pmatrix} \dfrac{2H^2}{c^2} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} - \kappa p^* \eta^{*}_{ik} = \kappa T^{*}_{ik}\,. \tag{21}$$

This form $E^*_{ik}$ of the original covariant Einstein tensor without cosmological constant $\Lambda$, and thus the corresponding stationary energy-stress tensor $T^*_{ik}$ too, are completely independent of time, what also applies to their contravariant tensor densities $\mathbf{E}^{*ik}$ and $\mathbf{T}^{*ik}$ straightforwardly. It may be mentioned in this context that Einstein's 'geodesic' law of motion does not only result as usual from the mixed form $T^{k}_{i;k} = 0$ but from the contracted Bianchi identities $T^{ik}_{\;;k} = 0$, too, where the last would include the constant tensor density $\mathbf{T}^{*ik}$ twice.

According to (21) the stationary model is demanding a negative gravitational 'dark' pressure $p^* = -\varepsilon_c/3$ of matter statistically at rest, where $\varepsilon_c = 3H^2/(\kappa_E c^2)$ equals the critical energy density (obviously, in this view $p^*$ corresponds to something like a cosmological 'constant'). To state it explicitly, however, this stationary gravitational pressure $p^*$ *must* be negative [Ostermann 2003] because:

Let a subvolume of a large hall, which is filled with ordinary dust, be separated in a box. Since the situation in the box will stay the same after all matter outside the box is removed, this implies a positive pressure of the dust because the walls of the box are exerting a force inwards to bar the dust from diffusion. Now in contrast, consider a separate subvolume of a stationary universe including a plenty of galaxy clusters without peculiar velocities. *Then there must be a negative pressure equivalent to hypothetical walls which in this case had to pull* outwards*, to prevent the homogenous distribution of galaxy clusters inside from massing together due to their mutual attraction, after those outside had been fictively removed.*

To apply Einstein's equations according to the conventional perfect fluid treatment, one may define two other scalars

$$\mu_F^* c^2 = \tfrac{2}{3}\varepsilon_c \, e^{-2Ht^*} , \tag{22}$$

$$p_F^* = -\tfrac{1}{3}\varepsilon_c \, e^{-2Ht^*} \tag{23}$$

in addition to the particle quantity $\mu_N^*$ given by (17) and the constant pressure $p^* = -\varepsilon_c/3$ above. Then the usual form of $T^*_{ik}$ in (21) looks like the well-known purely phenomenological energy-momentum-stress tensor

$$P_{ik}^* \equiv \mu_F^* c^2 u_i^* u_k^* - p_F^* g_{ik} . \tag{24}$$

Note that inserting $p_F^* = 0$ into (24), however, the corresponding mixed tensor $P^*{}_i^k{}_{(p^*_F=0)}$ is not the same as $K_N{}^*{}_i^k$ of (6), because the first one is that of an idealized 'perfect-fluid', whereas the second one is that of a universal distribution of 'particles' in their mutual gravitational field. That the latter is the appropriate representation reflecting stationarity has been shown in the previous section.

Even using $P^{*ik} = g^{il}g^{km}P^*_{lm}$ according to (24) it is possible to verify once more the equilibrium of the universal matter-energy distribution derived from Einstein's 'geodesic' equations above. Though, in case of a fluid with non-vanishing variable pressure $p_F^*$, the 'geodesic' equations of motion corresponding to (8) can only apply to each of its elements for a special kind of 'free fall' where – writing $\partial^i \equiv g^{ik}\partial_k$ – it is

$$c^2 u^i \partial_k \left(\mu_F u^k\right) = \sqrt{g}\,\partial^i p_F \ . \tag{25}$$

A conclusion from $\mu_F^*$ instead of $\mu_N^*$ on rest masses of 'particles', however, is impossible since (25) shows that no continuity equation of matter is valid there. Thus, though galaxies or clusters may be regarded as 'particles' in the universal gravitational field, this does not apply to arbitrary parts of the ultra-large scale matter-energy distribution described by a perfect fluid tensor $P^*_{ik}$. Nevertheless, evaluating (25) in case of SUM, this relation is fulfilled taking into account (22), (23) and $u^{*0} = e^{-Ht^*} = 1/u_0{}^*$ corresponding to (14) directly.

Regarding the same relations, it has to be kept in mind that also $\mu_F{}^*{}_{(t^*=0)}$ and $p_F{}^*{}_{(t^*=0)}$ are representing unchanged values for arbitrary reference points of universal time again and again, since $t^*$ always means $t_R^* + \Delta t^*$ where any reference point of time may be set $t_R^* = 0$. No mean temporal changes can occur locally. Only in form of spatial relations, there are corresponding changes, while any intervals $\Delta t^* = \Delta l^*/c$ between events in different locations are mathematically determined by the universal light time to cover the respective distances.

Besides the constant mass-energy density $\mathbf{T}^{*ik}$ stated above, the complete conservation laws of GRT are in general $\partial_k \mathbf{V}^{ik} = 0$, strictly valid for the bi-tensor density $\mathbf{V}^{ik} = \mathbf{T}^{ik} + {}_{(\mathrm{bi})}\mathbf{t}^{ik}$ [Rosen 1940, 1963], which in addition allows for a covariant exchange with the energy of gravitational waves. The quantity ${}_{(\mathrm{bi})}\mathbf{t}^{ik}$ means more than a 'pseudo'-tensor density in general; but with regard to the universal frame here also the quantity $\mathbf{t}^{ik} = {}_{(\mathrm{bi})}\mathbf{t}^{ik}$ is a true bi-tensor density of the gravitational field (s. Appendix A).

In case of SUM, it is $\mathbf{V}^{*ik} = \mathbf{T}^{*ik} + \mathbf{t}^{*ik} = \varepsilon_c \,\mathrm{diag}(0, {}^4/_3, {}^4/_3, {}^4/_3)$. Remarkably the obvious result $\mathbf{V}^{*00} = 0$ holds for Einstein's [1916] original definition of $t^{ik}$ as well as for several alternative definitions, see e.g. Landau & Lifschitz [1992] or Weinberg [1972]. At first glance it may look strange that the total energy density of matter and gravitational field should be zero, though. But in a quasi-local system S' of integrated coordinates with limited spatial and temporal applicability (Section 2.4) there will be found $\mathbf{V}'^{ik} = \mathbf{T}'^{ik}$ as another result with non-zero total energy and even locally fulfilling the ordinary conservation laws.

According to SUM there should be a stationary mutual exchange of energy and pressure between $\mathbf{T}_i^k$ and ${}_{(\mathrm{bi})}\mathbf{t}_i^k$ even if gravitational waves might be partially absorbed after emission by the overall 'dark' matter (before they would reach distant observers or corresponding detectors in their expected form).

Independent of questions caused by the traditional assignment (24), now in particular with the constant number density of universal objects given in 'comoving' coordinates, the rest mass conservation stated in the previous section does not only apply to microscopic particles but also to gravitationally bound systems up to galaxies or even clusters. Therefore – regarding those structures statistically at rest – this means a conservation of universal mass-energy, too, thus corresponding to the evidently stationary covariant energy-stress tensor (21) or its contravariant density immediately. The conventional perfect-fluid interpretation based on the time-dependent mixed tensor $T_i^k$, however, might together with the bi-tensor ${}_{(\mathrm{bi})}t_i^k$ of the gravitational field account for 'local' processes of emergence and disappearance instead.

### 2.4 The limitations of proper length and proper time

Natural atomic clocks do not continuously tick intervals of universal time d$t^*$, but intervals of local 'proper' time again and again. Correspondingly, natural rods do not always and everywhere show constant intervals of universal length d$l^*$. In contrast, their local realizations have *approximately* to fulfil

$$\mathrm{d}\sigma^{*2}_{\mathrm{SRT}} \overset{!}{\approx} \mathrm{e}^{2Ht^*}\left\{c^2\mathrm{d}t^{*2} - \mathrm{d}l^{*2}\right\} . \tag{26}$$

Using atomic clocks and spectral rods, the intervals of proper time and length are directly measurable only within sufficiently small regions, which are local with respect to universal space as well as to universal time. Thus these intervals are defined always together according to the line element of SRT

$$\mathrm{d}\sigma^2_{\mathrm{SRT}} = c^2\mathrm{d}t^2_{\mathrm{SRT}} - \mathrm{d}l^2_{\mathrm{SRT}} \tag{27}$$

in local inertial frames. There, to avoid unnecessary assumptions, it is always sufficient to understand 'proper time' as a display of atomic clocks, and 'proper length' as a number of spectral unit sticks, both correspondingly affected by gravitational potential and universal motion.

Now, comparing the SRT approximation (26) of the universal line element (1) on the one hand with that of local SRT within freely falling inertial frames on the other hand, this immediately leads to fundamental relations between elements of universal coordinates (d$t^*$, d$l^*$) and local 'proper' coordinates (d$t_{\mathrm{SRT}}$, d$l_{\mathrm{SRT}}$). Thus according to (4), atomic clocks at rest (always with respect to the universal coordinate frame) show increasing intervals of local proper time d$t_{\mathrm{SRT}}$ and local proper length d$l_{\mathrm{SRT}}$, both displayed as

$$\mathrm{d}t_{\mathrm{SRT}} \approx \mathbf{e}^{Ht^*}\mathrm{d}t^* , \tag{28}$$

$$\mathrm{d}l_{\mathrm{SRT}} \approx \mathbf{e}^{Ht^*}\mathrm{d}l^* . \tag{29}$$

These relations imply an essential non-integrability of proper length and time which is obvious from the fact that it is simply impossible to write down a line element for a non-empty universe only using *both* 'proper' coordinate elements (d$t_{\mathrm{SRT}}$, d$l_{\mathrm{SRT}}$) exactly. Therefore the approximate symbol '≈' (and not an equal sign '=') has to be used here (s. also Section 2.7) due to limited SRT applicability.

In view of the non-existence of any fixed zero point $t_{\mathrm{R}}^*$ of the universal time $t^*$, though, there must be a self-restoring validity of SRT within local inertial frames. This is in accordance with processes which – in e.g. freely falling space labs with varying relative velocities – cannot continuously stay strictly compatible. In contrast, deviations from an idealized SRT behaviour actually increase with time. To give the impression of an uninterrupted macroscopic validity, it seems sufficient that SRT is strictly valid for each process connecting two *local* quantum leaps – i.e. between emission and absorption of photons underway in a Michelson interferometer – while a comparison of photons emitted and absorbed in different galaxies need a description by *universal* GRT. Any quantum leaps, however, may imply an appropriate adaption of involved proper quantities to restore local SRT again and again.

Such a feature does not at all seem impossible. Apparently related to the well-known phenomenon called 'reduction of wave packets', GR may apply that way to the universe in processes where QM is essentially involved. While in quantum leaps various physical possibilities are reduced to one single reality respectively, there is an analogy in the self-restoring aspects of SRT. Therefore the description of physical reality by both RT and QM might be effectively 'quantized' itself, thus corresponding to a sequence of single snapshots making a movie.

According to the equivalence principle there exists an approximate realization of the SRT line element (27) within local inertial frames. From (28), (29) the system S' of *integrated* coordinates ($r'$, $T' \equiv 1/H + t'$), implicitly given by

$$t^* \equiv \frac{\ln(HT')}{H} , \quad r^* \equiv \frac{r'}{HT'} , \tag{30}$$

transform the stationary line element (4) approximately into that of SRT

$$\mathrm{d}\sigma'^2 = \left[1 - \left(\frac{r^*}{R_{\mathrm{H}}}\right)^2\right]c^2\mathrm{d}T'^2 + 2\left(\frac{r^*}{R_{\mathrm{H}}}\right)c\mathrm{d}T'\mathrm{d}r' - \mathrm{d}l'^2 , \tag{31}$$

where $\mathrm{d}l'^2 = \mathrm{d}r'^2 + r'^2\mathrm{d}\Sigma'^2$ with d$\Sigma'$ the element of a Euclidean spherical surface. It is of decisive importance to see from (31) that in comparison to (27) the obvious condition

$$r^* \overset{!}{<} R_H , \tag{32}$$

with $R_H \equiv c/H$ the Hubble radius, is setting an uppermost limit for the validity of any approximate SRT concepts and processes transferred to cosmology. It seems even probable that more realistic limitations should be set by $r^* \ll R_H$, thus possibly indicating the extensions of galaxies, clusters, or Lyman-α blobs as those of local 'cosmoses', if necessary.

Therefore the integrated time $T' \equiv T_H + t'$ with $T_H \equiv 1/H$ as a quasi-Minkowskian coordinate approximation to a *local* proper-time integral $t_{\mathrm{SRT}}$ is not suitable to hold beyond coherent universal distances $r^* \approx R_{\mathrm{H}}$. In particular, the coordinate time $T'$ of any FLRW-form cannot be a uniform proper time all over the universe. Proper time is always given within *local* cosmic areas only, limited to extensions described by relation (32) above.

On the other hand, since no universal coordinate origin is preferred there may be many 'locally' coherent regions where the special-relativistic concepts of proper length and proper time approximately apply. The condition $T' \overset{!}{>} 0$, obvious from (30), means that no local structures should be older than $T_H \equiv 1/H$ with respect to their local quasi-proper time $t'$. Thus $T_H$ has not necessarily to be the age of the universe as a whole.

Particularly the overinterpreted SRT-based 'big bang' concept seems limited to local regions of gravitational creation. Such regions may be spread all over a stationary universe, where the material components are determined by the requirement that they are recreated in extreme gravitational centres – grown to hot originative 'local-bang' events – according to the laws of quantum physics at the same rates as they have disappeared before. This means that, even restricted to such local events, the material components of a stationary universe would exist at rates approximately calculated from the 'big bang' model so far.

### 2.5 Universal redshift without universal expansion

Only as long as the redshift of galaxies is understood to originate from an increase of real distances, this seems to imply a peculiar history of the entire universe. An associated Doppler approach, effectively underlying this hypothesis however, is questionable as already considered by Hubble [1929] himself. Above all, the concept of universal expansion inevitably would mean a 'schism of consistent physics' – particularly where superluminal – because of two different velocities between same physical objects (and the respective particles included).

In contrast, ordinary gravitational redshift in local fields, unexpectedly found by Einstein as a previously unknown effect before, has certainly nothing to do with any mysterious expansion. The SUM, as well as nearly every approach to cosmology today, is based on his fundamental equivalence principle demanding the validity of SRT in local inertial frames. Therefore the redshift of starlight from extragalactic objects can be interpreted as a particular extension of ordinary redshift to the gravitational 'potential' $e^{Ht^*}$ of the stationary universe. The argumentation is exactly the same which has led to (28), (29) above.

Keeping this in perspective, there is no need for a universal expansion, though a quasi-Doppler interpretation has been suggestive because time is involved. In fact, all cosmological solutions since Friedman(n)'s work are not static of course. In the SUM framework, however, this means nothing but local evolutionary processes, well compatible to full stationarity with respect to sufficiently large scales of space and time.

The most rational conclusion is that apart from the historical view, there are neither any reproducible facts nor any testable physical reasons which – applying Occam's razor – make a model of receding galaxies necessary for cosmology. Accordingly, now a detailed derivation will confirm that in spite of the time-dependent scalar $\zeta^*_{\mathrm{SUM}}$ (3) the line element (1) proves stationary again. In particular, the universal redshift of galaxies as the fundamental observational fact of cosmology will be found independent of time (except for peculiar motions). Consequently, this feature applies to all other quantities which are functions of $z$ too, like the apparent magnitudes of Supernovae-Ia (SNe) used as standard candles. Naturally it applies also to the Hubble constant $H$ in the SUM framework itself.

Starting from the assumption that – as verified by the special solution (13) in Section 2.2 – galaxies are statistically at rest with respect to universal coordinates, the redshift, as defined by

$$z \equiv \frac{\lambda_{\mathrm{A}}}{\lambda_{\mathrm{E}}} - 1 \ , \tag{33}$$

is calculated in complete analogy to the well-known gravitational redshift in local fields, where the indices 'E' and 'A' mean emission or absorption respectively.

As usual, consider the crest of a light wave emitted at universal time $t_{\mathrm{E}}^*$ anywhere at a distance $l^*$ in Euclidean (allegedly 'comoving') space, and then arriving at universal time $t_{\mathrm{A}}^*$. The following crest, emitted at the same place as before but at time $t_{\mathrm{E}}^* + \delta t^*$, will arrive at $t_{\mathrm{A}}^* + \delta t^*$ because of the constant universal speed $c^* = c$ of light. This means that the interval $\delta t^*$ – which is nothing but the oscillation period $\tau_0^*$ of propagating starlight with respect to universal time $t^*$ – has been transported and kept unchanged over an intergalactic distance $l^* = c\Delta t^*$, where $\Delta t^* \equiv t_{\mathrm{A}}^* - t_{\mathrm{E}}^*$.

On the other hand, a proper time interval $\delta t_{\mathrm{SRT}} = \tau_0$ of a natural atomic clock at rest is related to the corresponding interval $\delta t^*$ of universal time according to (28). Hence at the time $t_{\mathrm{E}}^*$ of emission and at the time $t_{\mathrm{A}}^*$ of arrival, the corresponding proper time intervals are

$$\tau_{\mathrm{A/E}} = \tau_0^* \mathbf{e}^{Ht^*_{\mathrm{A/E}}} \tag{34}$$

respectively. With regard to relation $\lambda = c\tau$ for wavelength and period of light, it follows immediately that the corresponding intervals of proper length and time will be different in a proportion

$$\frac{\lambda_{\mathrm{A}}}{\lambda_{\mathrm{E}}} = \frac{\tau_{\mathrm{A}}}{\tau_{\mathrm{E}}} = \mathbf{e}^{H\Delta t^*} , \tag{35}$$

where – because of the constant universal speed of light –

$$\Delta t^* = l^*/c \tag{36}$$

is just the positive transit time of extragalactic light. Obviously, the result (35) does not depend on single absolute values $t_{\mathrm{E}}^*$ or $t_{\mathrm{A}}^*$ of universal time, but only on their positive difference $\Delta t^*$ and the constant $H$. This is one more detailed example fulfilling the postulate of stationarity, because after having inserted $t_{\mathrm{A}}^* = t_{\mathrm{R}}^*$ and $t_{\mathrm{E}}^* = t_{\mathrm{R}}^* - \Delta t^*$ into (34), the physical results (35), (36) prove the non-occurrence of the arbitrary reference time $t_{\mathrm{R}}^*$ directly.

So far, $\tau_{\mathrm{E}}$ in (35) is only the proper time interval at the universal time $t_{\mathrm{E}}^*$ of emission whereas $\tau_{\mathrm{A}}$ is a proper time interval at the universal time $t_{\mathrm{A}}^*$ of absorption. But the actual question is to compare the oscillation period $\tau_{\mathrm{A}}$ with the oscillation period $\tau_0$ of new spectral radiation of same type, when both are emitted at place and time of absorption. It is obvious, however, that with respect to local proper time the oscillation period of one particular spectral line will be $\tau_{\mathrm{E}} = \tau_0$ again and again, which is a constant at place and time of its origin. This is a direct consequence of Einstein's equivalence principle. If using natural atomic clocks, the same statement would be a mere tautology, because the design of those clocks is just based on this constancy.

Since measuring means comparing, the common constant factor $e^{Ht_{\mathrm{R}}^*}$ which would explicitly appear in numerator and denominator of (34) cancels out. Displayed on clocks is respectively only a number, i.e. the *quotient* of measured natural quantities and corresponding local natural units; these are changed at the same rate.

Now, inserting the 'infinitesimal' wavelengths $\lambda_{\mathrm{A/E}} = c\,\tau_{\mathrm{A/E}}$ according to (35) into (33), the redshift parameter $z$ is found completely independent of time for starlight emitted from sources at rest:

$$z = \mathbf{e}^{Hl^*/c} - 1 \quad \Leftrightarrow \quad l^* = \frac{c}{H}\ln(1+z)\,, \tag{37}$$

where $l^* = c\,\Delta t^*$ is the covered universal distance. Therefore, to get a simple explanation for the redshift of galaxies it is sufficient to make the difference between local proper intervals ($\delta t_{\mathrm{SRT}}$, $\delta l_{\mathrm{SRT}}$), and universal intervals ($\delta t^*$, $\delta t^*$) according to (28), (29). Not only the redshift, but also the corresponding time dilation is clearly confirmed in particular by the SNe-Ia measurements quoted in Section 3 below.

With the Hubble law (37) applying to galaxies statistically at rest, i.e. $l^*$ = constant relative to the isotropic background (or also to the CMB if in a common state everywhere), here is a contradiction to the traditional understanding of supposedly meaningless system coordinates of GRT. The reason is that in addition to a local 'proper' length $\Delta l_{\mathrm{SRT}}$, any universal quantity $l^*$ is actually a real physical distance measure by time-independent mean values of $z$ according to (37).

Thus, the SUM makes the difference to all other flat space models of GRT. The striking proof of stationarity is of course clearly what has been aimed at by introducing the exponential ansatz for the universal time scalar (3). In fundamental contrast it is usually concluded from (29) on the other hand,, that fixed values of $l^*$ should mean increasing proper distances, what historically needed to understand the universal coordinates as 'comoving' ones. As already has been shown in Section 2.4, however, any proper distances would be inappropriate to cover the universe.

Concerning another unexpected problem of relativistic cosmology in this context, it may be already stated here that there is a subtle but far-reaching difference between the time-dependent conventional Hubble parameter and the significant constant $H$ occurring in (37). This will be cleared up in Section 2.7.

Now, from the quantum mechanical energy-frequency relation for photons – but also deducible from classical electrodynamics in GRT – and with

$$\nu_{\mathrm{E}} \equiv \nu_{\mathrm{A}}(1+z) \tag{38}$$

according to (33), the extended form (37) of Hubble's originally linear law shows that the redshift also applies to photon energies as

$$\delta\varepsilon_{\mathrm{A}} = \delta\varepsilon_{\mathrm{E}}\,\mathbf{e}^{-Hl^*/c}\,. \tag{39}$$

Re-substituting $l^*$ by $c\Delta t^*$ here, the cosmic redshift apparently requires the energy of free photons to decrease with universal time relative to local absorbers. Such a time-dependent energy loss of free photons might look like a violation of an overall energy conservation, but given a stationary universe, with respect to ultra-large scales it is not. In this case, with statistically constant values of $l^*$, relation (39) may be understood a stationary energy loss affecting the whole of free photons respectively (s. however Section 5.3). Its mathematical form is exactly that of the familiar law of ordinary attenuation, what includes the hypothetical absorption once assumed by Olbers [1823] in a proposal to solve his famous paradox (thus the beginning of modern cosmology). The main objection made against Olbers' hypothesis has been taken up in the SUM framework (s. [SUM14/ 2.8]) and will be questioned again or even finally disproved in Section 5.3.

Furthermore, relation (39) may be also regarded as completion of both relations (28), (29) in that it affects mass as the third basic quantity of physics. In this context, on the one hand, it has to be taken into account that statements about homogeneously distributed matter are not applicable straightforwardly to the energy of propagating photons. But on the other hand, the energy differences of atoms at rest before and after emission, naturally agree with the energy of the corresponding photons at place and time of their origin. In any case, however, a relation corresponding to (39) does neither apply to the rest mass of particles constituting cosmic rays nor to that of galaxies, for example, which all are conserved according to (19).

Altogether, with respect to universal coordinates now measurable by their constant redshift parameters, except for peculiar motions or any processes of re-formation, galaxies as well as other universal objects statistically stay where they are. This fundamental feature is in accordance with time independence of the Hubble constant again.

The history of a traceably mistaken Hubble parameter mathematically related to 'proper' distances is discussed elsewhere in detail [SUM14/A1]. Basis is the undisputed matter of course that with respect to 'comoving' (actually universal) coordinates galaxies statistically stay at rest.

### 2.6 The magnitude-redshift relation

Given a universal object (U) of absolute radiation power $L_{\mathrm{U}}^*$ at a constant distance $r^*$ with respect to universal coordinates, the SUM implies the apparent luminosity

$$I_{\mathrm{U}}^* = \frac{L_{\mathrm{U}}^*}{4\pi r^{*2}}\,\mathrm{e}^{-(2+\kappa)\frac{r^*}{R_H}}\,, \tag{40}$$

which is the bolometric intensity of the radiation observed per square unit, and locally measured per unit of proper time. Here from the redshift relation (37) a first factor $e^{-r^*/R_H} = 1/(1+z)$ results as usual by application of the quantum mechanical energy-frequency relation of photons equivalent to (39), and a second factor $e^{-r^*/R_H}$ from the relative dilation (34) in comparison with the local proper time of the measuring device. Furthermore, taking into account possible effects of attenuation like extinction, absorption, scattering, or obscuring, there is a corresponding coefficient $\kappa$ in (40) which is set constant here (though applying to spectral distributions it may be taken a function of frequency if necessary).

Obviously $\kappa/R_H$ corresponds to the reciprocal of a mean free path of the respective radiation. Inserting

$$r^* = R_H \ln(1+z) \tag{41}$$

taken from (37) leads to

$$I^*_{\mathrm{U}}(z) = \frac{L^*_{\mathrm{U}}}{4\pi R_H^2}\left[(1+z)^{1+\frac{\kappa}{2}}\ln(1+z)\right]^{-2} . \tag{42}$$

This relation is neglecting any 'local' cosmic evolution and does not yet take into account thinkable effects of inhomogeneities or any systematic peculiar flows of our cosmic environment. To compare the result (42) with the SNe-Ia magnitude-redshift data directly, it has to be converted to the distance modulus

$$m - M = 5\log\left(\frac{d^*_{\mathrm{L}}}{\mathrm{Mpc}}\right) + 25 , \tag{43}$$

where $m$ is the apparent magnitude, $M$ represents an appropriate value for the absolute standard brightness of e.g. SNe Ia, and $d_{\mathrm{L}}^*$ is the luminosity distance, here

$$d^*_{\mathrm{L}} \equiv \sqrt{\frac{L^*_{\mathrm{U}}}{4\pi I^*_{\mathrm{U}}}} = r^*(1+z)\,\mathrm{e}^{\frac{\kappa}{2}r^*/R_H} , \tag{44}$$

which then may be written as a pure function of redshift

$$d^*_{\mathrm{L}}(z) = R_H (1+z)^{1+\frac{\kappa}{2}} \ln(1+z) . \tag{45}$$

Inserting this into (43) yields the stationary magnitude-redshift relation

$$m_{\mathrm{SUM}} - M = 5\log\left[(1+z)^{1+\frac{\kappa}{2}}\ln(1+z)\right] + 25 + 5\log\left(\frac{R_H}{\mathrm{Mpc}}\right) \tag{46}$$

Since for sources at rest in universal coordinates the redshift parameters $z$ are independent of time, so are the magnitudes and all other quantities, which are functions of $z$. It is relation (46) for the distance modulus which will be shown in Section 3 to fit the SNe-Ia magnitude-redshift observations on universal scales with no need for any universal expansion or 'dark energy'. That this accordance applies straightforwardly in the high redshift range $z > 0.1$, is just reflecting the intention that (4) should describe the universe on ultra-large scales where it is justified to assume the averaged densities to be homogenous and isotropic. More details and possible effects due to a local Hubble contrast $\delta H/H$ (or additionally due to dimming by a small amount of intergalactic 'grey dust') will be explicitly addressed in Section 3.2.

For each cosmological model in question, particularly the distance modulus is of fundamental interest, since it establishes a clean relation between the directly measurable values of apparent magnitudes $m$ and the redshift parameters $z$. In contrast to today's 'dark' interpretation this relation is actually uncontaminated by cosmological priors. It is also remarkable, that the SNe-Ia data did not show any significant cosmic evolution, thus indicating a stationary validity of local physics again.

### 2.7 Pseudo-proper FLRW form and the SUM scale factor

The varied genesis of GRT may have been the reason that Einstein's [1912] insight into the non-integrability of proper length and proper time apparently passed into oblivion.

In contrast to Section 2.4 retaining the universal distance $r^*$ and, somewhat half-heartedly, only transforming the universal time $t^*$, this procedure would have resulted in a Friedman(n)-Lemaître-Robertson-Walker (FLRW) form. Thus, to directly compare the stationary SUM line element with today's Cosmological Concordance Model, it is particularly instructive now to rewrite (1) traceably in such a traditional FLRW form which – given spatial flatness and keeping $l^{*\alpha}$ the universal ('comoving') coordinates – may be written as

$$\mathrm{d}\sigma'^2_{\mathrm{FLRW}} = c^2\mathrm{d}t'^2 - a^2\mathrm{d}l^{*2} , \tag{47}$$

where preliminarily $a \equiv a(t')$ is the general scale factor. Obviously $t'$ is the FLRW coordinate time which will be referred to as the *integrated* coordinate time, since it is given by direct integration of (28) after having replaced $\mathrm{d}t_{\mathrm{SRT}}$ by $\mathrm{d}t'$ and the sign '≈' by '='. These replacements are necessary because the local intervals of proper time $\mathrm{d}t_{\mathrm{SRT}}$ and proper length $\mathrm{d}l_{\mathrm{SRT}}$ are not integrable without changing their respective character (hereafter indicated by an inverted comma like in $t'$). The integrable FLRW time $t'$, though, cannot be understood as a valid 'cosmic proper time', otherwise the expression $a^2\mathrm{d}l^{*2}$ of (47) had to be identical to $\mathrm{d}l^2_{\mathrm{SRT}}$. If, however, in the locally valid relation

$$\mathrm{d}l_{\mathrm{SRT}} \approx a\,\mathrm{d}l^* , \tag{48}$$

an equal sign '=' was used instead of the approximate sign, the whole relation (47) would be nothing but the line element of SRT itself – whose Riemann, Ricci, or Einstein tensors and therefore the entire universal mass energy density would mathematically vanish to zero.

As consequences of this necessary distinction there are intrinsic limitations of proper length and time. Because of the non-integrability, already stated in Section 2.4 explicitly, it is

$$l' \neq a l^* \tag{49}$$

contrary to a naive overstrained interpretation of (48). In particular there is no unlimited increasing universal 'proper' distance $l'$.

Now a determination of the stationary scale factor $a_{\text{SUM}}$ can be done by a simple transformation of the universal time $t^*$ to the integrated quasi-proper time $t'$ or $T' \equiv T_H + t'$, where $T_H \equiv 1/H$, without thereby changing any relevant physical results. Using the relation $t^* = \ln(HT')/H$ taken from (30), the corresponding coordinate transformation of (1) yields the FLRW-form corresponding to the original SUM line element

$$\mathrm{d}\sigma'^2_{\text{SUM-FLRW}} = c^2 \mathrm{d}T'^2 - a^2_{\text{SUM}}\left(\mathrm{d}r^{*2} + r^{*2}\,\mathrm{d}\Sigma^{*2}\right), \tag{50}$$

where $r^*$ is the radial distance and $\mathrm{d}\Sigma^*$ the element of a Euclidean spherical surface in universal coordinates. Then the SUM scale factor

$$a_{\text{SUM}} \equiv HT' \equiv 1 + Ht', \tag{51}$$

equals the stationary time scalar $\zeta^*_{\text{SUM}}$ (3) as is obvious from the first relation in (30). – In contrast, the SST scale factor $a_{\text{SST}} = e^{Ht'}$ would result in a horizon problem corresponding to a seemingly small, but physically essential difference in the line element, which difference in view of the SUM is regarded an unacceptable feature.

The seeming singularity of (50), (51) at $T' = 0$, however, cannot disprove the *universal* SUM stationarity found in the previous sections, because: According to the covariance of GRT, the alternative FLRW representation of SUM must yield the same directly observable physical results as the original stationary line element (4) of the ultra-large scale background universe. It is easily verified, for example, that from (50), (51) the exact Hubble relation (37) holds in its time-independent form, too. Keeping the full stationarity of all corresponding results it may be emphasized here, that this stationarity is a coordinate-free statement, while any apparent singularity means an inadequacy in the mathematical treatment.

What in view of the singularity in (50), (51) is otherwise called 'age of the universe', now in view of SUM turns out to be rather the maximum age of macroscopic structures according to Section 2.4. Seemingly opposite observations of e.g. oldest galaxies cannot convince of a singular origin. This in analogy to the commonplace experience that the existence of people with each member not older than about one hundred years does not prove this individual maximum lifetime to be the age of the whole population.

In contrast to the natural search for the vital history of our cosmos it does not make sense to search for a continuous history of the entire universe. The discovery in our Milky Way of SMSS 03132-6708 [Keller et al. 2014], with an age concluded to be about 13.6 Gyrs, raises serious doubts in formation particularly of a star only 200 Myrs after the alleged 'big bang' of the universe (a previous observation has been that of HD 140283, the 'Methuselah star' [Bond et al. 2013], with an assumed age of even 14.46 ± 0.8 Gyrs). This seems to indicate that low-iron population II stars might still form much later than assumed in the CCM framework. In remarkable contrast, from the perspective of SUM it could be more plausible that metal-poor stars also in globular clusters might be *younger* than those of population I. Such a scenario would correspond to an on-going universal re-creation of hydrogen.

In the context of the assumed ages above, it may be mentioned that according to SUM the maximum mean universal lifetime of macroscopic structures should be $T_H \equiv T_{\text{SUM}} \equiv 1/H_{\text{SUM}} \approx 15.0$ Gyrs (instead of $T'_{0\text{-CCM}} \approx 13.8$ Gyrs).

It is not only of historical interest that in contrast to the *conventional* Hubble parameter $H_{\text{c}} \equiv \dot{a}/a$ the significant value is $H = H_{\text{s}} \equiv \dot{a}$. Otherwise, since in case of SUM the conventional parameter $H_{\text{c}}(t')$ would yield the time-dependent value $1/T'$, it might be confusing to have found the stationary redshift (37) actually independent of time.

In view of far-reaching consequences, it seems necessary to show explicitly, that independently of the respective scale factor $a(t')$ also in general the significant FLRW Hubble parameter is $H_{\text{s}} \equiv \dot{a}$, what – only if given the stationary scale factor $a_{\text{SUM}} \equiv HT' \equiv 1 + Ht'$ – actually means a true Hubble constant $H_{\text{s-SUM}} \equiv H$ indeed.

With regard to the general FLRW-form (47), the definition of redshift, $z \equiv \lambda_{\text{A}}/\lambda_{\text{E}} - 1$, can be written in the well-known form

$$z \equiv \frac{a(t'_{\text{A}})}{a(t'_{\text{E}})} - 1 \equiv \frac{\Delta a_{\text{AE}}}{a(t'_{\text{E}})} \approx \frac{\dot{a}}{a}\Delta t', \tag{52}$$

where a dot means differentiation with respect to $t'$ or $T'$. Since light propagates according to $\mathrm{d}\sigma_{\text{FLRW}} = 0$ with FLRW coordinate velocity $c' = c/a$, and a local element of proper length is assumed to be $\Delta l' \approx a\Delta l^*$, it is

$$\Delta t' \approx \frac{a\Delta l^*}{c} \quad \Leftrightarrow \quad \Delta t' \approx \frac{\Delta l'}{c}, \tag{53}$$

Inserted both equivalent expressions into (52) it follows at first Hubble's linear law in its *significant* form

$$cz \approx \dot{a}\,\Delta l^* \equiv H_{\text{s}}\,\Delta l^*, \tag{54}$$

as well as the approximate law in its *conventional* form

$$cz \approx \frac{\dot{a}}{a}\Delta l' \equiv H_{\text{c}}\,\Delta l', \tag{55}$$

where according to (53) the expression $\Delta l' \approx c\Delta t'$ is usually regarded the 'proper' distance to the light source.

Even in view of traditional cosmology, however, the conventional assignment of the Hubble parameter $H_\mathrm{c}$ on the right hand side of (55) is misleading. By definition it is not the pseudo-proper distance $l'$ but the universal ('comoving') distance $l^*$ which is *constant*$|_{t^*}$ for galaxies without peculiar motions. Therefore not the intervals $\Delta l'$ in (55) are presupposed to be independent of time, but the intervals of universal distance $\Delta l^*$ instead. Thus clearly relation (54) is the valid approximation (for a discussion of the historical context s. [SUM14/A1]).

Concluding this section it may be emphasized once more that in contrast to the stationary universal line element (4) itself, the FLRW-form (47) with its scale factor $a_\mathrm{SUM}(t') \equiv HT' \equiv 1+Ht'$ is no longer without a mathematical singularity. But there are the intrinsic limitations of proper length and proper time revealed in Section 2.4, which have to be taken into account. Accordingly it is important to keep in mind that from (31) it has to be $r^* < R_H$ or even $r^* \ll R_H$. Thus in view of SUM any pseudo-proper FLRW form, if understood to apply to the entire universe instead of only 'local' regions, is effectively misleading.

### 2.8 Large-scale distribution of universal objects

As is well-known, the universe seems irregularly structured by filaments, superclusters, voids, and walls, interfused with corresponding densifications of 'dark' matter and an inter-galactic medium. Except for field galaxies, most of the other seem gravitationally bound to dark-matter halos of clusters with an intra-cluster medium, where hot gas is emitting X-ray radiation. Several types of galaxies seem dominated by dark-matter, stars, and various amounts of inter-stellar medium, the latter primarily containing cosmic rays, gas, or dust. While stars are the sources of stellar radiation, dust clouds seem the main source of (far-) infrared radiation. It has to be taken into consideration that 'dark' matter may be the main source of a universal microwave radiation in addition to the mm-range of the cosmic infrared background (CIB). Now a theoretical distribution of universal objects U will be roughly estimated here as a function of $z$.

Considering an idealized uniform number density $n_\mathrm{U}^*$ of homogeneously distributed objects like stars, galaxies, quasars or clusters, for example, the number of them included within a spherical shell between $r^*$ and $r^* + dr^*$ is

$$\mathrm{d}N_\mathrm{U}^* = n_\mathrm{U}^* \mathrm{d}V^* = 4\pi n_\mathrm{U}^* r^{*2} \mathrm{d}r^* \tag{56}$$

with

$$n_\mathrm{U}^* = \frac{\Omega_\mathrm{U} \rho_\mathrm{c}}{M_\mathrm{U}}, \tag{57}$$

where as usual $\Omega_\mathrm{U}$ is the parameter of a mean matter density given by $\mu_\mathrm{U}^* \equiv \Omega_\mathrm{U} \rho_\mathrm{c}$, and $M_\mathrm{U}$ the mass of a typical object. Inserting (57), as well as $r^*$ and $\mathrm{d}r^*$ taken from (41), into (56) yields

$$\frac{\mathrm{d}N_\mathrm{U}^*}{\mathrm{d}z} = 4\pi n_\mathrm{U}^* R_H^3 \frac{\ln^2(1+z)}{(1+z)} \tag{58}$$

not yet taking into account any effects of possible absorption, selection, or local evolution. The total number of respective objects is $N_\mathrm{U} = \infty$ of course (as easily demonstrated by integration). This natural result corresponds directly to the concept of the SUM, since the underlying stationary line element (4) does not imply any horizons of the universe as a whole.

The idealized distribution (58) shows a flat peak at $z_\mathrm{SUM} = \mathrm{e}^2 - 1 \approx 6.4$ while it is approximating zero in the limit $z \to \infty$. The value $z_\mathrm{SUM}$, though, seems clearly above the observed maximum at $z_\mathrm{obs} \approx 1.9$ of quasi stellar objects (QSOs). However, the steep decrease of the quasar distribution in the interval $2 < z < 4$ to almost zero as shown in [Schneider et al. 2010], for example, does not necessarily mean a steep decrease in the actual number density, because there is implied a selection bias due to a magnitude limit of e.g. 20.2 mag. In particular Appendix C.3 will come back to this subject.

At any point of universal time there should be extragalactic objects in any possible stadium of formation.

### 2.9 No need for one singular 'big bang' out of nothing

It is widely believed that at least on Planck scales General Relativity (GR) and Quantum Mechanics (QM) prove incompatible. Such a statement, however, seems premature as long as – after a necessary clarification (s. Appendix A) – Einstein's equations

$$R_{ik} - \frac{1}{2} R g_{ik} = \kappa T_{ik}^\text{QM–detailed} \tag{59}$$

are not solved consistently for a detailed quantum energy-momentum-stress (EMS) tensor on their right hand side. Here again $E_{ik}$ is the Einstein tensor, $R_{ik}$, $R$ are the Ricci tensor and its scalar, $g_{ik}$ the fundamental tensor, and Einstein's constant $\kappa_\mathrm{E}$ means $8\pi G/c^4$ (not to be confused with the absorption coefficient $\kappa$). In Einstein's 'extended' equations there would be an additional term $\Lambda g_{ik}$ (with $\Lambda$ his cosmological constant).

Thus far, in many important cases Einstein's original equations are successfully solved only for his phenomenological substitute $T_i^k := P_i^k$. This tensor is essentially describing a perfect fluid, whose provisional nature once let him write of 'lumber instead of marble' [Einstein 1936].

Since 'relativity' – initially based on the principle of no preferred system – has effectively established a universal CMB restframe, however, something might have been mistaken there. Consequently, in contrast to unambiguously testable physical concepts, historical terms like 'relativistic' or 'spatial curvature', for example, may not be taken literally in the context of Einstein's wonderful equations. To demonstrate the evidence of this claim, a simple derivation of Riemann's non-Euclidean line element is given in the appendix just mentioned above without referring to any physical properties of space and time themselves.

A first step to a quantized EMS tensor $T_{ik}{}^{\text{QM-detailed}}$ of matter has been proposed in the outline of a unified theory of electrodynamics, quantum mechanics, and gravitation [Ostermann 2008a, RKQ08/V] based on a still incomplete variational principle, however. While regarding the Klein-Gordon equation, a limited mathematical consistency seems already achieved there, this feature might be also established dealing with the Dirac equation on base of underlying relations as exemplarily given in Appendix A again, where a corresponding deduction is shown in its compressed form.

In spite of the fact, that *exact* detailed quantum solutions of (59) may be found rarely if at all, a resignation in view of the assumed incompatibility of GR and QM seems unjustified. As soon as one discards the strictly geometric interpretation of GR, most of the fundamental problems rather vanish into new chances – from particle physics up to cosmology. There is simply no need for geometric properties of space and time instead of physical properties of material objects to recover the immense plenty of experimentally verified results (Appendix C.3.2). Accordingly any attempt to quantize a mathematical 'spacetime' itself instead of real physical matter would make no sense

To state this explicitly, the objective is to find respective tetrads $e^a{}_i$, which would determine Einstein's fundamental tensor $g_{ik}$ in such a way that the appropriate detailed quantum EMS tensor of matter will identically result on the right hand side of (59). Indeed, such a procedure can only work in four-dimensional *universal* coordinates of GRT (but not at all based exclusively on any 'proper spacetime' concept).

It is impossible to do cosmology without appropriate principles which – besides the indispensable compatibility to observational facts – should fulfil the criteria of simplicity, adequacy and clarity. In the absence of such criteria not even the decision between a heliocentric and a geocentric conception of our planetary system would be possible within GRT because of legitimate mutual coordinate transformations. A central idea leading to SUM as the stationary cosmological solution of Einstein's equations is that no universal horizons must limit physical reality where locally, together with gravitation, quantum mechanics reveals its full creative potential.

It has to be stated, though, that given a stationary background universe – this view strongly supported by the Supernovae Ia magnitude-redshift measurements – hot originative 'local bang' events seem to violate an unrestricted validity of the law of entropy. On the other hand, a single-bang origin of the universe as a whole would have violated *all* physical laws since *none* such laws could have existed within sheer nothing.

Unnecessary speculations about varying laws of nature do make no physical sense, because either such pseudo-laws change systematically with time, what would be only another unchanging law. Or they change untraceably and therefore unpredictably. In both cases they would make any valid conclusion impossible for serious physics.

Since 'local bangs' may actually take place as indicated by explosion of hypernovae, GRBs, QSOs, or AGNi, the stationary universe might be interpreted as 'tohu-va-bohu' – with all due respect – in which our own evolutionary cosmos originated billions of years ago [Ostermann 2004, SUM14/T1]. Already at that time, however, eternal laws of nature must have been in this anything but senseless chaos.

If a real CCM cosmos had a quasi-singular beginning approximately 13.8 Gys in the past, then according to SUM this cosmos can be only a known part of the stationary background universe today. An infinite number of many cosmic areas might arise and pass by in such a 'multiverse' again and again, just like the stars, galaxies, clusters, and all individual beings therein. There would be a struggle of ultra-large scale entropic balance against local evolution with no need for a physical beginning of space and time themselves (s. Appendix 3.1).

From the Lambda-Cold-Dark-Matter (ΛCDM) 'flat space' model follows a limited region of observability within $r^* \approx 3.4 R_{H0}$. Nevertheless, the reason, why it is highly implausible to assume an embedding of such corresponding multi-bang 'parallel-universes' into the stationary background universe (the latter described by SUM) lies in the fact that this assumption would need an anthropic explanation for the almost perfect isotropy of the CMB radiation actually observed. But any 'anthropic explanation' is unacceptable for the universe, since it does violate what Bondi – unfortunately ignoring the fundamental extension by Thomas Digges – has called the 'Copernican principle'.

In completion to the presupposed continuous homogeneity of the ultra-large scale universe, it may be realistic to describe our evolutionary cosmos by basically inhomogeneous approaches as e.g. in [Buchert 2000/01], [Wiltshire 2007], [Coley 2010], [Buchert & M.Ostermann 2012], [Wiegand, Buchert, & M.Ostermann 2014], where possible effects of 'backreaction' may be taken into account.

The final reason that in the SUM framework there is no need for one singular 'big bang' out of nothing lies in the local limitations of proper length and proper time (Sections 2.4, 2.7) which have been unfortunately ignored from the beginning of relativistic cosmology. Several historical concepts were overestimated for a long time.

According to SUM there is no ultimate fate of the universe, but an eternal interplay of local collapse and gravitational re-creation in corresponding explosions instead. Also in such scenarios no *physical* singularities must exist.

## 3 THE SUPERNOVA-IA BREAKTHROUGH IN ACCORDANCE WITH SUM

Using SUM's FLRW form (50) (51), now it is easy to compare its scale factor $a_{\text{SUM}}$ to that of today's Cosmological Concordance Model $a_{\text{CCM}}$ directly.

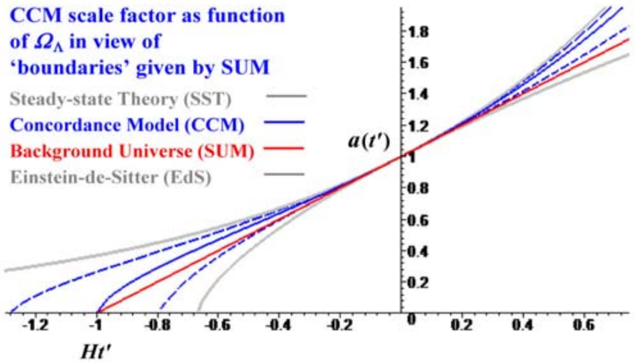

FIGURE 1. – Top-down on the left: $(\Omega_M, w_M, \Omega_\Lambda) = (0,0,1), (0.1,0,0.9), (0.27,0,0.73), (1,-{}^1\!/_3,0)$, $(0.6,0,0.4), (1,0,0)$, i.e.: Steady-state Theory $a_{SST}(t') = e^{Ht'}$ [upper grey solid line, this model discussed as a possible option in the past], a first alternative to $a_{CCM}(t')$ with higher value of $\Omega_\Lambda$ [blue broken line], today's concordance model $a_{CCM}(t')$ [blue solid line, see (60), (61)], stationary ultra-large scale universe $a_{SUM}(t') = HT' = 1+Ht'$ [red straight line, s. (51)], a second alternative to $a_{CCM}(t')$ with lower value of $\Omega_\Lambda$ [lower blue broken line], Einstein-de-Sitter model $a_{Eds}(t') = (1+{}^3\!/_2 Ht')^{2/3}$ [lower grey solid line, favoured before the SNe-Ia observational breakthrough]. In contrast to (all) other values (blue broken lines), the CCM best-fit parameter $\Omega_\Lambda = 0.737$ (blue solid line) seems determined by the condition that it should meet the SUM scale factor (red straight line) at its 'boundaries', i.e. at its beginning $Ht' = -1$ exactly and at $Ht' = 0$ approximately today.

According to a phenomenological pressure of matter $p_M \approx 0$ today and also setting $\Omega_R \approx 0$ (for radiation), Einstein's extended equations yield the effective CCM scale factor $a_{CCM}(t')$ for a spatially Euclidean model

$$a_{CCM}(t') \;=\; \left[\left(\frac{1}{\Omega_\Lambda} - 1\right)\sinh^2 X\right]^{1/3} \tag{60}$$

with here temporarily

$$X \;=\; \frac{1}{2}\ln\left(\frac{1-\sqrt{\Omega_\Lambda}}{1+\sqrt{\Omega_\Lambda}}\right) - \frac{3}{2}\sqrt{\Omega_\Lambda}\,H_0\,t' \tag{61}$$

by direct integration. Even taking the CMB radiation density yet into account, this does not result in visible changes of the solid blue CCM-line in Figure 1, which has been already discussed [Ostermann 2004] after the first WMAP results [Bennett et al. 2003].

From the claim, that the FLRW singularity (otherwise 'age of the universe') should correspond to infinite past in universal time $t^* = -\infty$ it follows $T'_0 \overset{!}{=} 1/H_0$ today. Then the numerical solution of (60), (61) is $\Omega_\Lambda = 0.737$, $\Omega_M = 0.263$, thus almost perfectly matching the first-year CCM density parameters for 'dark energy' ($\Omega_\Lambda = 0.73 \pm 0.04$) and matter ($\Omega_M = 1 - \Omega_\Lambda$) reported in the WMAP-paper quoted above, in case a spatially flat model is presupposed (as otherwise according to SUM). Later on, this aspect has been pointed out also by Melia & Shevchuk [2012].

### 3.1 Evidence from the magnitude-redshift data on universal scales (z > 0.1)

With redshift parameters $z$ independent of time and a constant universal speed of light $c^* = c$ the most natural conceivable cosmological solution (4) of general relativity stands out from all others. The new stationary universe model turns out to represent the SNe-Ia data of Riess et al. [2004, 2007] in the high redshift range $z > 0.1$ surprisingly well. Only in the low range $0.01 < z \leq 0.1$ its luminosity predictions differ from those of today's CCM significantly. It has been shown, however, that instead of an accelerated expansion, a local Hubble contrast seems to result in agreement with the low redshift data, too.

At first the original gold-sample of the Riess et al. SNe Ia data compilation is used here containing 140 ground-discovered plus 30 HST-discovered SNe-Ia (11 HST-'silver' data have been included for illustration). After evaluation of the SUM magnitude-redshift relation (46) – here according to Riess et al. simply setting $\kappa = 0$ – Figure 2(a) shows the corresponding SUM prediction (red solid line) on universal scales $z > 0.1$ together with those of the CCM and two flat space models once prominent in the history of relativistic cosmology [the Steady-state Theory (SST) at the top and the Einstein-deSitter (EdS) model at the bottom]. In 1998/99 an observational breakthrough to completely unexpected SNe-Ia data seemed to require a 'strange recipe'. Mixing about 1/4 of the EdS cosmology to about 3/4 of the old SST led to today's CCM. – From

$$m_{CCM} - M \;=\; 5\log\left[(1+z)\int_0^z \frac{dz'}{\sqrt{(1-\Omega_\Lambda)\,(1+z')^3 + \Omega_\Lambda}}\right] + C \tag{62}$$

according to (60), (61) with temporarily

$$C \;=\; 25 + 5\log\left(\frac{c/H}{\text{Mpc}}\right) \tag{63}$$

the CCM cosmology is represented by the bold blue line, fitting the SNe-Ia data numerically well (an insignificant contribution $\Omega_R$ due to radiation is neglected as usual),

Besides the achievements of COBE [Mather et al. 1990], WMAP [Bennett et al. 2003], HST Key Project [Freedman et al. 2001], the HST Calibration Program [Sandage et al. 2006], and SDSS [Kessler et al. 2009], [Schneider et al. 2010], there are the decisive SNe-Ia data of the *High-z Supernova Search Team* (HZT) [Riess et al. 1998, 2004, 2007] on the one hand, as well as those of the *Supernova Cosmology Project* (SCP) [Perlmutter et al. 1999], [Kowalski et al. 2008], [Amanullah et al. 2010], [Suzuki et al. 2012] on the other hand. These data may represent the most valuable cosmological measurements of the last decades. Though they have been understood to provide evidence for a 'universal acceleration' driven by 'dark energy', the SNe-Ia data are of exceptional importance because their immediate confrontation with competing theories is least hampered by input of unproven hypotheses about the universe.

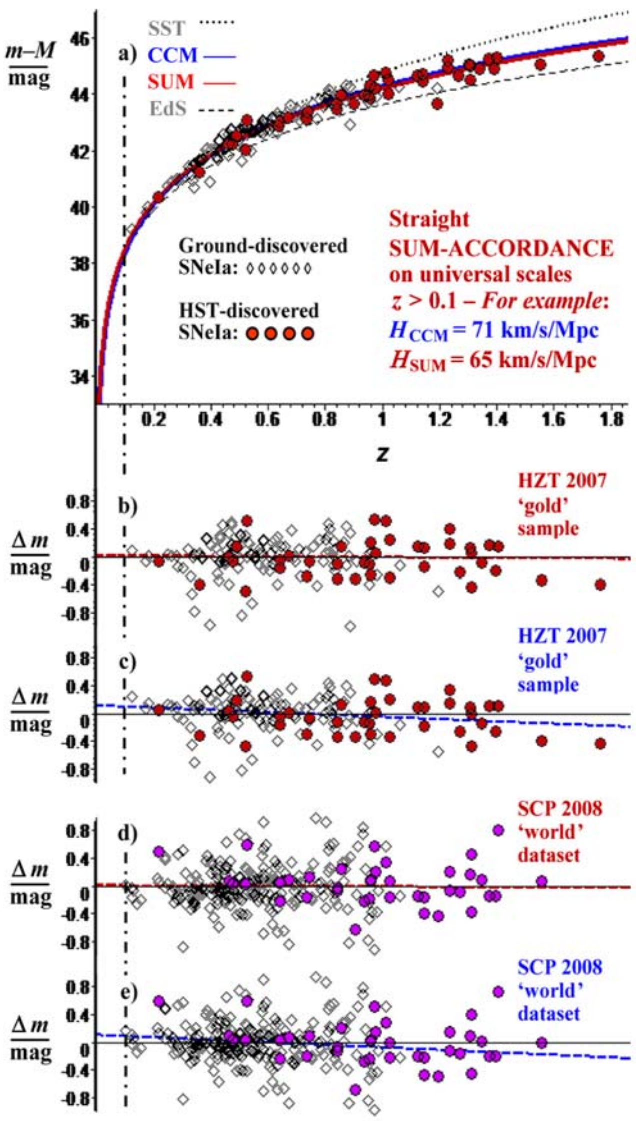

FIGURE 2. – *Top panel (a)*: – Comparing the SUM magnitude-redshift prediction (46) for $\kappa = 0$ with the SNe-Ia data and the CCM-prediction, there is a straightforward SUM agreement on large universal scales $z > 0.1$ where the universe may be rightly regarded homogeneous and isotropic. The red SUM-line coincides almost completely with the blue CCM-line (though of a 9% higher Hubble constant). *Lower panels (b) – (e):* These Figures are of high importance, since here, in the high-redshift range $z > 0.10$ again, the pure model predictions are compared without any local corrections. Like the red broken lines, also the blue broken lines do not represent the predictions but the mean residuals with respect to the z-axes, i. e. deviations from the data.

## 3.2 Full scale compatibility of e.g. the Riess 'gold' sample in case of a local Hubble contrast

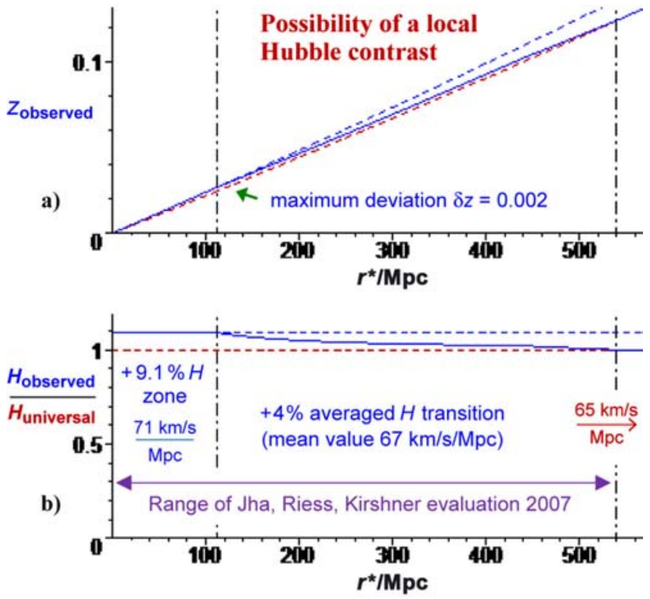

FIGURE 3. – *Upper panel (a):* The blue solid line represents the real values $z_{observed}$ of the SNe-Ia measurements, the red broken line the SUM neglecting possible peculiar flows or local inhomogeneities. The maximum deviation $\delta z \approx 0.002$ ($\approx$ 660 km/s/c) within $z < 0.027$ corresponds to a maximum contrast $H_{local}/H_{universal} - 1$ of about 9.1% at this point where $H_{universal}$ = 65 km/s/Mpc. – *Lower panel (b):* Within $r^* < 113$ Mpc the blue line corresponds to $H_{local}$ = 71 km/s/Mpc, while the mean value in the transition zone (up to $z \approx 0.13$) is $H_{trans} \approx$ 67 km/s/Mpc. The difference 71 – 67 = 4 km/s/Mpc corresponds roughly to the local Hubble contrast $H_{local}/H_{trans} - 1$ which seems effectively to have been reported by Jha, Riess, & Kirshner [2007] to be 6.5% ± 1.8%.

The high quality of the SNe-Ia data allows to search for an alternative explanation. In fact there is another chance, actually for a universe without unnecessary coincidences, horizon problems or other peculiarities [Ostermann 2003, 2004, RKQ08/II,V, VIII]. Even straight away for $\kappa = 0$, the solid line of the SUM-prediction (46) would fit the data much better than EdS or SST. Furthermore, a vertical shift of $\Delta m = 0.17$ has been used in Figure 2 to remove *all visible* differences between the red SUM-line and the blue CCM-line. This vertical shift does mean nothing but a local relative increase $H_{local}/H_{universal} - 1$ of about 9% in the Hubble constant (if for example $H_{CCM}$ = 71 km/s/Mpc then $H_{SUM}$ = 65 km/s/Mpc). In comparison, the reported values were between 62 km/s/Mpc [Sandage et al. 2006] and 72 km/s/Mpc [Freedman et al. 2001] until recently.

In both panels of Figure 3 the solid blue lines may represent the real SNe-Ia observations, the broken red lines respectively below do represent straight SUM. A maximum deviation $\delta z \approx 0.002$ corresponds to a maximum Hubble contrast of +9.1%.

With $H_{universal}$ = 65 km/s/Mpc e.g. this would mean $H_{local}$ = 71 km/s/Mpc within $r^* < 113$ Mpc ($z < 0.025$), while the mean value in the transition zone is about $H_{trans} \approx$ 67 km/s/Mpc. The local contrast (71 – 67) km/s/Mpc = 4 km/s/Mpc corresponds roughly to the absolute difference of 6.5% ± 1.8% as found by Jha, Riess, & Kirshner [2007].

Just recently, by the second of these authors, there has been reported another "local value" $H_0 \approx$ 73 km/s/Mpc, now with an uncertainty of only 2.4% [Riess et al. 2016].

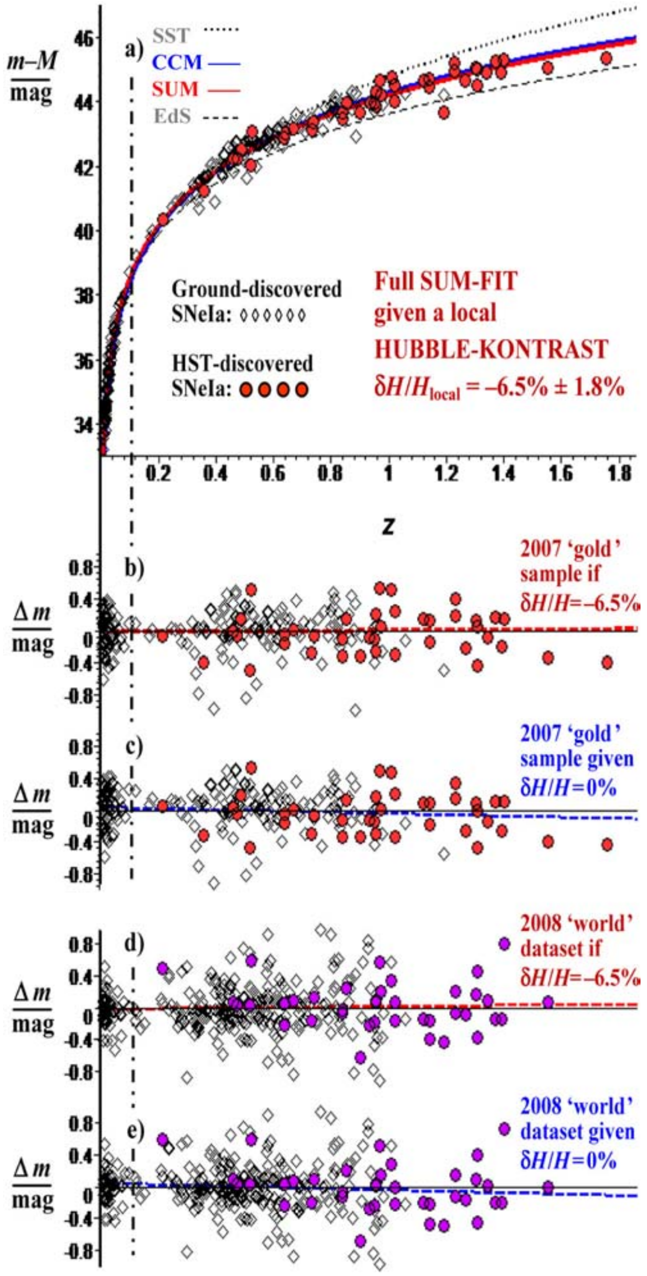

FIGURE 4. – Taking into account a local Hubble contrast as shown in Figure 3, there is a full scale SUM compatibility with not only the SNe-Ia data of the HZT [Riess et al. 2004, 2007], but also with those of the SCP's 2008 'world' compilation [Kowalski et al. 2008]. The assignment $\delta H/H_{\mathrm{local}}$ given in this figure means $H_{\mathrm{trans}}/H_{\mathrm{local}} - 1$, thus roughly within the relative difference range of –6.5 % ± 1.8 %. Obviously the corresponding corrections of at most $\delta z \approx 0.002$ within $z_{\mathrm{corrected}} < 0.027$ are sufficient to cause a reasonable accordance between the SUM and the data in the low redshift range, too. – In the panels (b) - (e) again, the red and blue broken straight lines are determined by the method of least quadratic deviations and should ideally prove congruent with the z-axis.

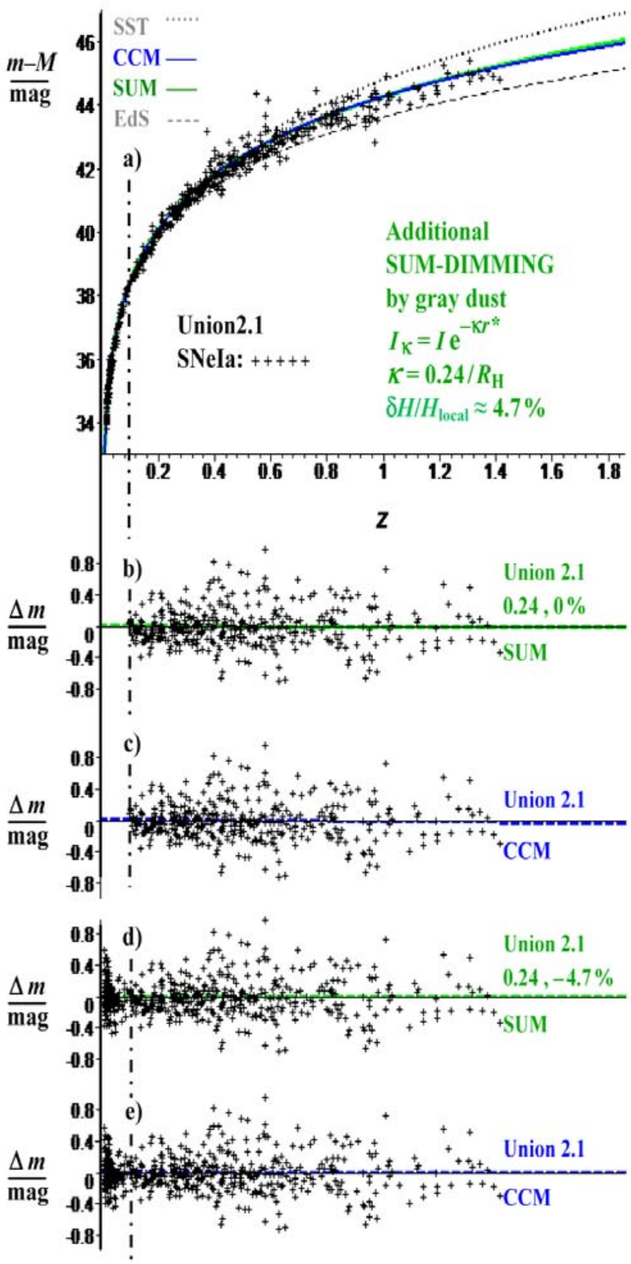

FIGURE 5. – These *panels* show corresponding illustrations for the Union 2.1 results [Suzuki et al. 2012], [Amanullah et al. 2010], where a value $\kappa$ = 0.24 is exemplarily tested (while in the mm-microwave frequency range a different value of $\kappa$ would apply for absorption, s. text below).

Close to Freedman's value of 72 km/s/Mpc [2001], but in clear contrast to 67 km/s/Mpc predicted by ΛCDM cosmology from the new PLANCK high-redshift measurements [Aghanim et al. 2016] – or approximately also the 68 km/s/Mpc of Cheng Cheng & Qing-Guo Huang [2015] – this remarkably means a Hubble contrast of about +9% again, which would almost perfectly match the original SUM prediction [Ostermann 2012a] concluded above (s. lower panel of Figure 3). Apparently the authors of the new report presuppose the 'curved' shape of a ΛCDM Hubble diagram (without explicit justification) and therefore, of course, cannot find any difference between the local and global value of the Hubble constant. This seems to be also the reason that the Hubble contrast previously reported by Jha, Riess, & Kirshner [2007] is no more discussed. There, however, it convincingly read: "… the feature is present in the Hubble flow SN sample, and this has important implications for using SN Ia as tools for precision cosmology."

More general than relation (4) underlying (46) directly, there might also apply an embedded line element

$$d\sigma^* \;=\; e^{H(t^*,\vec{r}^*)\,t^*} d\sigma^*_{\mathrm{GRT}}\,, \tag{64}$$

where $d\sigma^*_{\mathrm{GRT}}$ is determined outside of matter by Einstein's vacuum equations $R_{ik} = 0$. With $\overline{H^2(t^*,\vec{r}^*)} \equiv H^2$, relation (64) averaged over universal scales yields (4) again.

The panels (a), (b), (d) of Figure 4 show that after taking into account the local Hubble contrast of Figure 3, now the SUM-residuals result in reasonable agreement with the low redshift data, too (whereas in this case the CCM might face a serious problem in the low redshift range $z < 0.1$ now). If necessary, there might be also an additional adaptability from effects like dimming by grey dust[$\kappa = 0.24$ in combination with $\delta H/H_{\mathrm{local}} = -4.7\%$ in green panels (a), (d) of Figure 5].

Independent of any local peculiarities, however, the only decisive feature is the straightforward agreement on *universal* scales $z > 0.1$ according to panels (a), (b), (d) of Figure 2 or to the panels (a), (b), (d) of Figure 4 respectively on the right hand side of the vertical dashed lines, where the model predictions are compared without any local corrections. These panels prove a straight SUM accordance on scales $z > 0.1$ with the 'gold' sample of Riess et al. [2004, 2007] as well as with 'The World's Supernova Distance-Redshift Data' [Kowalski et al. 2008].

The question remains, how the same data could be understood to have proved the existence of a 'dark energy' in ΛCDM single-bang cosmology, though completely incomprehensible so far (a probable answer is given in Appendix C.2). In contrast to the hypothetical CCM conclusion from the SNe-Ia data of a corresponding universal acceleration, however, now here is the traceable chance for a paradigm shift to a stationary background universe model (multiverse) as described by SUM.

Regarding the full redshift range, either these SNe-Ia data are explained by SUM taking into account a local Hubble contrast ($H_{\mathrm{local}} > H_{\mathrm{universal}}$ as actually observed), or they are explained by the CCM requiring a mysterious 'dark energy' due to an unnecessary 'accelerated expansion of the universe'.

## 4 HOMOGENEOUSLY DISTRIBUTED DARK MATTER AS THE NATURAL ALTERNATIVE TO 'DARK ENERGY'

A vast isothermal main part of homogeneously distributed dark matter of second kind (hDM) might exist instead of the 'dark energy' assumed today. Until now, only the smaller known inhomogeneous part (iDM) is commonly accepted in form of dark matter halos, whether or not bound to galaxies or clusters. The additional macroscopically non-lensing hDM would fill the gap between observable matter and critical density, the latter required by any flat space solutions of Einstein's gravitational equations.

Furthermore, dark matter of weakly interacting particles could be at least partially responsible for the observed cosmic microwave background radiation. It does not necessarily consist of only one fraction of particles; various components may also include unseen macroscopic objects. In the framework of SUM – and in accordance with the universal Supernova Ia data – an alternative Planck microwave background will be shown to be at least mathematically composable of redshifted radiation emitted within the universe (s. Section 5).

Thus 'dark' matter may get rid of its mysterious lack of non-gravitational interaction. Both forms might possibly even absorb some intensity of gravitational waves in various frequencies ranges (although in case of e.g. the binary pulsar PSR 1913+16 [Hulse & Taylor 1975] the corresponding loss of potential energy obviously exists, its emission is not yet directly observed so far).

### 4.1 Lensing dark matter of first kind (iDM)

Dark matter seems necessary to explain the otherwise unexpected rotation curves in galaxies [Rubin 1998], [Rubin & Ford 1970] or the puzzling peculiar velocities in clusters [Zwicky 1933], as well as gravitational lensing far from visible objects.

A natural question is: What is the temperature of that macroscopically lensing dark matter of first kind (iDM), which is observable by its inhomogeneous distribution (whether baryonic or not)? A simple calculation like in particular that of a pure Emden sphere (singular isothermal) suggests the essential feature of approximately constant velocities. On the assumption that pressure, volume, and temperature of simplified hypothetical iDM distributions are related in the same way as in regular gases, there appear rotation curves similar to those actually observed if only in each galaxy the temperature of this dark matter took a respective (nearly) constant value.

In view of the ΛCDM cosmology, any ideas that dark matter might consist of massive 'thermal' neutrinos seem disproved. But according to SUM, from non-zero rest masses there follows that neutrinos – despite propagating after release at almost the speed of light – will be slowed down by deceleration of free particles in the gravitational field of the infinite universe (s. Section 2.2). At thermal velocities they may show unexpected features.

Also a possible mean mass of iDM particles might be estimated in order of magnitude. From the simplifying assumption of an isothermal distribution leading to the observed rotation curves in our galaxy would follow roughly 1/1000 the mass of the electron. Such an order of magnitude might indicate thermal neutrinos again. In this view a search for candidates of iDM particles in the high energy range of e.g. the LHC would seem not promising.

### 4.2 Non-lensing dark matter of second kind (hDM)

In addition to the currently assumed inhomogeneous parts, a macroscopically non-lensing hDM distribution (dark matter of second kind as an approximately homogeneous isothermal background) could instead of 'dark energy' fill the gap to critical density. The same hDM then may be the main source of a universal microwave radiation, where what is called CMB would be only the dominating 'black body' part in contrast to the mm-range of the 'additional' cosmic infrared background.

The nature of possible hDM particles raises the question of non-baryonic dark neutrino matter again. If spin-½ particles are primarily involved, then in spite of all 'big bang' counterarguments these particles might yet be neutrinos. A reason is that on basis of the following consideration other such candidates are possibly not available, because: The number of 24 elementary spin-½ particles seems to be – in full accordance with the standard model of particle physics – related to the 24 components of a real torsion tensor as explicitly addressed in the next section.

Summarizing the various aspects, the universal 'dark' matter distribution may be similar to that of a viscous medium filling universal space. This would be realized, though, with local overdensities in form of bulges, halos or clusters gathering stars and galaxies, while in huge 'voids' between them the density is low but yet high enough to make the dominant fraction of matter and energy. There may be different sorts of that 'dark' matter, one of them consisting of non-baryonic particles like e.g. thermalized neutrinos, the other one consisting of unknown baryonic objects cold and small enough to be 'invisible' for telescopes. Together with local inhomogeneities these could make up a universal non-lensing background. Even a possible contribution of gravitons cannot be excluded from consideration today.

In contrast to candidates for dark matter particles in the high energy range, low-energy neutrinos seem notoriously difficult to detect. If a homogeneous distribution of neutrinos was responsible for the CMB, however, as once more briefly addressed in Section 5.1, then actually the only observable effect to detect it might be the emission of the hDM radiation according to Figure 6.

### 4.3 Numerical hints to the existence of 24 elementary spin-½ torsion particles

Though of unprecedented numerical success in describing the observational facts of modern cosmology, there is another strange hint that the inflationary ΛCDM big-bang model might fail, namely because of an apparent materialization of an antisymmetric torsion tensor

$$T_{ikl}\ . \tag{65}$$

The universe seems constituted of 24 elementary spin-½ particles which are 6 leptons + 3 colours · 6 quarks. These curling structures, behaving as 'whirl' particles, may represent exactly the 24 components of a real torsion tensor which are 6 'temporal' + 3 · 6 'spatial' constituents

$$T^{i}_{\ kl} = T^{0}_{\ \alpha\beta} + T^{\gamma}_{\ \alpha\beta}\ , \tag{66}$$

what can be more than a mere coincidence [here Latin indices $i, (k \neq l) = 0,1,2,3$ in contrast to Greek spatial indices, here $\gamma, (\alpha \neq \beta) = 1,2,3$ only].

In addition, of the 6 'lepton'-components in $T^{0}_{\ \alpha\beta}$ there may be 3 'electric' + 3 'magnetic' (according to the assignment in the electromagnetic field strength tensor), thus reflecting three $e$, $\mu$, $\tau$ particles plus three respective $\nu_e$, $\nu_\mu$, $\nu_\tau$ neutrinos

$$T^{0}_{\ \alpha\beta} = T^{0}_{\ 0\alpha} + \left(T^{0}_{\ 32} + T^{0}_{\ 13} + T^{0}_{\ 21}\right). \tag{67}$$

As has been shown by Landau & Lifshitz [1992] long time ago, however, the physical existence of a non vanishing torsion tensor would contradict Einstein's equivalence principle. This principle is underlying the literally geometric interpretation of his gravitational equations, while in view of SUM the geometric approach fails in reducing physics to exclusively Riemannian properties of non-Euclidean space and time as also indicated by the existence of tetrads (Appendix A). Therefore not only a microscopic violation of the fundamental equivalence principle would contradict the whole spacetime concept where today's Concordance (Consensus) Model of cosmology is relying on.

In view of extended elementary spin-½ torsion structures (in most situations identifiable and acting as wholes) also Heisenberg's uncertainty principle can be understood in contrast to the strange behaviour of 'point' particles otherwise unrealistically presupposed so far.

It remains the possibility, though, that a corresponding antisymmetric $T_{ikl}$ has not necessarily to be a materialization of a real torsion tensor. As an example, also a tensor $X^{klm} = R^{iklm}_{\ \ \ \ ;i}$ built from the Riemann tensor might be associated instead.

In any case, contrary to its historical reception, quantum mechanics may be understood as theory of extended whirl structures of variable shape (i.e. as theory of possible 'torsion particles'). A first deductive attempt to extended structures (outlined in [Ostermann 2008a, RKQ08]) seems to explain Bohr's energy-frequency formula and to imply Heisenberg's uncertainty relations in accordance with approved principles of relativistic physics. Thus this feature is shown to be anything but an incomprehensible surprise after all.

Particles like electrons and protons as well as their constituents are neither real mass points without any extensions nor one-dimensional 'strings', nor two or higher-dimensional 'branes', but they are three-dimensional deformable structures with particle parameters in form of several characteristic constant integrals pertaining to rest mass, charge, and spin among others. This concept, though, does not deny fundamental achievements of mathematical abstractions (like in particular the concept of 'point masses' in Newtonian mechanics), of course.

Also the quantum mechanical result that particles do not have an unambiguous momentum is only a natural statement in view of interacting extended structures, where a possibly varying momentum *density* is self-evident. On the other hand, in spite of unavoidable uncertainties due to relative inner motions, the total momentum of a free particle can be exactly determined. While inner details may prove strange, the natural laws behind should be clear.

In contrast to solid bodies, remarkable characteristics of torsion structures are a completely different steadiness and their temporally dissolved identities. It is obvious that a theory of elementary whirl particles subdivides kinematics and dynamics of existing structures from a theory of production and transformation ('Erzeugung und Verwandlung' in Einstein's words). Contrary to naive point-particle models, the new concept allows a fundamentally simple understanding of transformations. While concerning free motion of whole objects, only kinematics may be of interest, in particle physics inner forces play the decisive role. Even the indistinguishability of elementary particles of same kind – otherwise a complete mystery – is no longer unintelligible as well as interference and diffraction phenomena.

The torsion model is independent of the question whether such particles may exist as material objects in vacuum or in form of whirl structures in a continuously extended medium. Nature may show both aspects (like spiral nebulae in a background of dark matter, for example). Taken together it seems an evident chance that:

- *Elementary particles are whirl structures (torsion particles).*
- *Whirl structures can stay consistent over astronomical periods of time due to the conservation of their angular momentum.*
- *Like macroscopic whirl structures also microscopic torsion particles are subject to processes of production and transformation.*
- *During transitional phases, whirl structures lose their identity.*
- *On the one hand, torsion structures are best described in some situations as particles.*
- *On the other hand, torsion structures are best described in some situations as waves.*
- *In whirl structures, detailed velocities of their components together with the averaged velocities of their mass centres are realized simultaneously, what quite naturally implies 'uncertainty relations' and indeterminism of a presupposed particle behaviour.*

Thus the elementary particles, which are assumed to constitute the entire universe, are essentially different from those solid eternal 'atoms' of the pioneering antique philosophers Leucippus and Democritus.

Since it is clear that only at the price of unavoidable uncertainties torsion structures can be dealt with as extensionless point particles, a complete relativistic mechanics has to contain a future consistent formulation of quantum theory. As addressed in Appendix A, an appropriate basis will be Rosen's bi-metric relativity [Rosen 1940, 1963] after fixation to the (preferred) universal frame.

## 5 A MICROWAVE BACKGROUND OF REDSHIFTED RADIATION WITHIN THE STATIONARY UNIVERSE

Overcoming the initial concept of dark matter without non-gravitational interaction opens the chance for an assumed CMB origin within a stationary universe.

There, all radiation must be emitted *and* absorbed internally, which statement has to hold particularly for a microwave background. Except for the unrealistic case of complete opaqueness, however, any omnipresent black-body radiation seems impossible at first sight because of universal redshift. Nevertheless here is a possible origin of the microwave background from everywhere.

Several considerations show not only the possibility but do even suggest the existence of such a DM black-body background as predominant radiation emitted stationarily. A tentative SUM approach assumes that this microwave radiation originates essentially from an approximately homogeneous fraction of 'dark'-matter distributed in voids (as well as much smaller parts from the inhomogeneous fraction iDM in halos like those of galaxies or clusters).

At first a perfect cosmic black-body microwave background has been shown mathematically composable of redshifted radiation according to the stationary universe model in [SUM14]. As considered here in Section 4, this CMB might be emitted from a macroscopically non-lensing hDM background. Such a feature should be falsifiable by observations of the SZ effect (SZE) [Sunyaev & Zeldovich 1970, 1980]. Unexpectedly in the ΛCDM framework the PLANCK 2015 data show a model prediction mismatch between observed and predicted SZ cluster counts [Ade et al. 2015/XXIV].

Previously Lieu, Mittaz, & Zhang [2006] pointed out a puzzling WMAP discrepancy between predicted and detected SZE profiles, reflecting how a cosmological CMB origin could be reconciled with their results. In another context, Efstathiou & Migliaccio [2012] stated that "Early expectations that measurements of the tSZ effect […] could be used for precision cosmology now seem naive."

It has been shown in Section 3, that in the SUM framework the Supernova-Ia data agree straightforwardly with the Nobel-prize awarded measurements on universal scales $z > 0.1$ without any need for 'dark energy'. Taken together with the PLANCK 2015 data and other CCM peculiarities now it seems reasonable to reconsider the CMB and in particular its origin again.

## 5.1 Mathematical composition

Apparently the only chance for a mathematical composition of the CMB from unknown universal hDM contributions seems to work as follows.

In a non-expanding stationary universe the spectral density of a gravitationally redshifted black body (BB) radiation, where $z = \mathrm{e}^{Hl^*/c} - 1$, would be

$$\rho_{\nu,\Theta} \;\equiv\; \rho_{\nu,\Theta_\mathrm{E}/(1+z)} \;=\; \frac{1}{(1+z)^{1+\kappa}}\,\rho_{\nu_\mathrm{E},\Theta_\mathrm{E}} \tag{68}$$

inclusive of absorption with constant $\kappa$. As usual, emitted frequencies and corresponding temperatures have to be replaced by

$$\nu_\mathrm{E} \;\equiv\; \nu\,(1+z)\,, \quad \Theta_\mathrm{E} \;\equiv\; \Theta\,(1+z)\,, \tag{69}$$

where in accordance with (38) an index '$_\mathrm{E}$', indicating 'emission', means any respective quantity at place and time of its origin.

Even in a stationary universe the locally emitted radiation itself has not necessarily to be of pure black body type. Given a frequency-dependent emissivity $\beta_\mathrm{hDM}(\nu_\mathrm{E} < 10^{12}\,\mathrm{Hz})$ at a constant mean temperature $\Theta_\mathrm{hDM}$, the following composition leads to a perfect BB spectrum as observed in total of an ideal stationary microwave radiation:

$$\rho^*_{\mathrm{hDM}\,\nu} \;=\; \frac{8\pi h}{c^3}\int_0^\infty \beta_\mathrm{hDM}(\nu_\mathrm{E})\,\frac{\nu_\mathrm{E}^3}{\mathrm{e}^{\frac{h\nu_\mathrm{E}}{k\Theta_\mathrm{hDM}}}-1}\,(1+z)^{-2-\kappa}\,\mathrm{d}z \tag{70}$$

where

$$\beta_\mathrm{hDM}(\nu_\mathrm{E}) \;=\; \frac{h\nu_\mathrm{E}}{k\,\Theta_\mathrm{hDM}}\,\frac{1}{1-\mathrm{e}^{-\frac{h\nu_\mathrm{E}}{k\,\Theta_\mathrm{hDM}}}}\,. \tag{71}$$

It is easily verified that in case of $\kappa = 2$ the integration of (70) yields exactly Planck's law

$$\rho^*_{\mathrm{hDM}\,\nu} \;=\; \frac{8\pi h}{c^3}\,\frac{\nu^3}{\mathrm{e}^{\frac{h\nu}{k\Theta_\mathrm{hDM}}}-1}\;. \tag{72}$$

The corresponding attenuation $1/(1{+}z)^2$ in the mm range would still allow measurements of quasars or radio galaxies (from e.g. $Z{=}6$ there would remain 1/49 the luminosity).

Regarding Figure 6 the bold broken red line shows the assumed emission of hDM radiation in a local sphere of 100 Mpc with its maximum photon energy of approximately 0.001 eV just at the SZE thermal null frequency 218 GHz. Together all respective local contributions would constitute the CMB as statistically observed everywhere in the universe.

In comparison it may be remarked that the lowest mass difference of neutrino oscillations is assumed to correspond to $\sqrt{(\Delta m_{21})^2} \approx 0.008\ \mathrm{eV}/c^2$ today [Olive 2014]. Both values just mentioned, though of neighboured orders in magnitude, may mean nothing, but – on the other hand – they do not exclude a chance that neutrinos might be involved in the emission of hDM radiation. If so, then in contrast to the relativistic neutrinos usually found, an unknown energy exchange possibly of oscillating thermal neutrinos might be responsible for interactions of 'dark' matter.

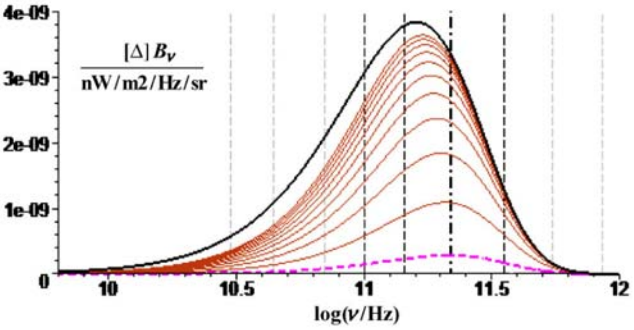

FIGURE 6. The bold solid black lines show the total CMB spectrum according to (70) for $\kappa = 2$ as actually observed. The bold broken red line shows the emission of the hDM radiation exemplarily in a local sphere of $\Delta r^* = 100$ Mpc as calculated from (79). In addition, the thin red solid lines show respective parts coming from within $z = Z$. The upper integration limit $\infty$ of relation (70) is replaced and evaluated there from bottom to top by $Z = 0.1, 0.2, .. 1.0$ respectively.

## 5.2 Split of the CMB emitted within or beyond $z = Z$

According to its mathematical composition above, there would result a split of the CMB statistically emitted within or beyond $z = Z$. In view of any local observer at $z = 0$ the total Planck spectral density (72) is found by integration of (70) to include two respective parts, where [with substitutions $x \equiv h\nu\ /(k\Theta_\mathrm{hDM})$, $Y \equiv 8\pi(k\Theta_\mathrm{hDM})^3/(h^2\mathrm{c}^3)$] the part emitted from beyond a redshift distance $z = Z$ results in

$$\rho^*_Z \;\equiv\; Y\frac{x^3}{\mathrm{e}^{x(1+Z)}-1} \;=\; Y\frac{x^3}{\mathrm{e}^{x}-1}\left\{1-\frac{\mathrm{e}^{x}(\mathrm{e}^{Zx}-1)}{\mathrm{e}^{x(1+Z)}-1}\right\}. \tag{73}$$

This is seemingly another Planck spectrum at mathematically reduced temperature $\Theta_\mathrm{Z} = \Theta_\mathrm{hDM}/(1+Z)$. According to (68) it apparently would equal the surface brightness from any black body at redshift $Z$ in local thermal equilibrium with the CMB of constant temperature $\Theta_\mathrm{hDM}$.

The thin red solid lines of Figure 6 show that by far most of the CMB radiation reaching the instruments would have been emitted within $Z < 1$. The bold red broken line raises the question of hDM particles again which would possibly emit radiation of a probably non-baryonic 'emissivity' in the corresponding frequency range.

This idealized local 'dark' emissivity $\beta(\nu_\mathrm{E})$ as theoretically found in (71) tends to the linear expression $h\nu_\mathrm{E}/(k\Theta_\mathrm{DM})$ for frequencies $\nu_\mathrm{E} \to \infty$. Such a behaviour cannot hold over the full frequency range, of course. Therefore in Figure 6 is used a cut-off with $\beta(\nu_\mathrm{E} < 10^{12}\,\mathrm{Hz})$ according to

(71) [otherwise $\beta = 0$] without visible deviations from a perfect Planck spectrum in the observable frequency distribution. The latter is shown here as black solid line.

In this context, also a non-thermal universal microwave synchrotron radiation from a cm to mm wavelength range is particularly observed in quasar spectral energy distributions, for example, as well as in the WMAP haze. While Hooper, Finkbeiner, & Dobler [2007] previously claimed "evidence of dark matter annihilations", recently Ade et al. [2011] stated "that the microwave haze is a separate component and not merely a variation in the spectral index of the synchrotron emission".

### 5.3 Universal radiation equilibrium

The mathematical solution for a perfect black-body spectrum of redshifted microwave radiation emitted from thermal hDM interaction may be more compactly written

$$\rho^*_{\mathrm{hDM}\,\nu} = Y \int_0^\infty \frac{x_\mathrm{E}^4\, \mathrm{e}^{x_\mathrm{E}}}{(\mathrm{e}^{x_\mathrm{E}}-1)^2} (1+z)^{-2-\kappa}\, \mathrm{d}z \tag{74}$$

using the abbreviations $x_\mathrm{E} \equiv h\nu_\mathrm{E}/(k\Theta_\mathrm{hDM}) \equiv h\nu(1+z)/(k\Theta_\mathrm{hDM})$ and $Y$ corresponding to those before. As well the constant $\kappa = 2$ still stands for an absorption factor $1/(1+Z)^2$ in the mm range. Correspondingly the mean free path of photons would be $R_H/2$ in this frequency range.

Unexpectedly an energetic equilibrium results for emission and attenuation in the same local shell, thus allowing a statistical energy recycling (possibly including hDM fall-in to active galactic nuclei). Even the photon energy loss due to redshift seems to be compensated.

On the one hand, according to the SUM concept there has to exist a universal radiation equilibrium. On the other hand – with respect to (68) and in contrast to emission from local black bodies only – it seemed impossible so far to keep a redshifted Planck spectrum of constant temperature $\Theta_\mathrm{hDM}$ within a stationary universe. Now to observe a *universal* BB background in equilibrium with all *local* counterparts, there have to be also non-thermal components, emitted in accordance with (74) replacing the integration limits by $Z$ and $Z + \Delta z$. Comparing the local radiance

$$\Delta B^{*\,\mathrm{local}}_\mathrm{hDM} = \frac{c}{4\pi} \Delta\rho^{*\,\mathrm{local}}_\mathrm{hDM} \tag{75}$$

in a shell of universal thickness $\mathrm{d}r^*$ with the local attenuation $\mathrm{d}A_\mathrm{hDM}{}^{*\mathrm{local}}$, the first is found after a re-substitution of $z$ according to (37). Setting $r^* = 0$, $x = x_\mathrm{E}$, and making use of

$$\rho^*_{\mathrm{hDM}\,\nu} = \frac{\mathrm{d}\rho^*_\mathrm{hDM}}{\mathrm{d}\,\nu} \tag{76}$$

it follows

$$\Delta B^{*\,\mathrm{local}}_\mathrm{hDM} = \frac{2\,(k\Theta_\mathrm{hDM})^4}{h^3 c^2} \frac{\Delta r^*}{R_H} \int_0^\infty \frac{x_\mathrm{E}^4\, \mathrm{e}^{x_\mathrm{E}}}{(\mathrm{e}^{x_\mathrm{E}}-1)^2}\, \mathrm{d}x_\mathrm{E}\,. \tag{77}$$

With the bolometric radiance of hDM black-body radiation

$$B^{*\mathrm{SB}}_\mathrm{hDM} \equiv \frac{2\pi^4}{15} \frac{k^4 \Theta^4_\mathrm{hDM}}{c^2 h^3} \tag{78}$$

according to Stefan-Boltzmann's law, relation (77) yields

$$\Delta B^{*\,\mathrm{local}}_\mathrm{hDM} = 4 B^{*\mathrm{SB}}_\mathrm{hDM} \frac{\Delta r^*}{R_H}\quad. \tag{79}$$

Expression (79) now turns out to equal the local attenuation $\mathrm{d}A^*{}_\mathrm{hDM}{}^\mathrm{local}$, because the effective attenuation in total of the hDM radiation (72) is due to local absorption *plus* local redshift

$$\Delta A^{*\,\mathrm{local}}_\mathrm{hDM} = (2+\kappa)\, \frac{2\big(k\Theta_\mathrm{hDM}\big)^4}{h^3 c^2} \frac{\Delta r^*}{R_H} \int_0^\infty \frac{x_\mathrm{E}^3}{\mathrm{e}^{x_\mathrm{E}}-1}\, \mathrm{d}x_\mathrm{E} \tag{80}$$

resulting in

$$\Delta A^{*\,\mathrm{local}}_\mathrm{hDM} = (2+\kappa)\, B^{*\mathrm{SB}}_\mathrm{hDM} \frac{\Delta r^*}{R_H}. \tag{81}$$

Given the assignment $\kappa = 2$ again, then – unexpectedly in these details – there is an energetic equilibrium for emission and total local attenuation in the same shell

$$\Delta B^{*\,\mathrm{local}}_\mathrm{hDM} = 4 B^{*\mathrm{SB}}_\mathrm{hDM} \frac{\Delta r^*}{R_H} = \Delta A^{*\,\mathrm{local}}_\mathrm{hDM}\;. \tag{82}$$

This result however, seems to imply the strange compensation also for energy loss by redshift mentioned above. The reason is that the factor $(2+\kappa)$ in (81) has to be regarded an effective 'extinction coefficient' $\kappa_\mathrm{effective}$ in the relevant mm range, where according to (40) its first summand "2" clearly originates from redshift. As stated in Section 2.6, one part of the latter is caused by local time dilation and the other part by the quantum mechanical energy-frequency relation of photons equivalent to (39).

Furthermore, the same result (82) would even suggest the possibility of a tentative answer to the general question, where the energy of any redshifted photons might be partially lost before they are absorbed anywhere in the universe. In view of SUM the seeming deficit would effectively correspond to the analogous outcome of ordinary gravitational redshift, where the 'kinetic' photon energy is partially converted to 'potential' energy and vice versa. Here it is presupposed naturally, that there must be an effective statistical energy re-cycling back from stellar radiation to keep the stars shining, though not forever the same.

In this context, it is simply wrong to claim an expanding universe necessary for a solution of Olbers' paradox. This has been easily shown [Ostermann 2003] by explicit direct calculation on base of relation (40) above.

### 5.4 Expected anisotropies, fluctuations, inhomogeneities

In accordance with the new concept, universal microwave radiation originates from 'dark' matter (various constituents), whose vast isothermal main part is distributed homogeneously (hDM instead of the assumed 'dark energy'), while a smaller inhomogeneous part, iDM, seems gravitationally condensed to halos (usual 'dark matter', whether or not bound to galaxies or clusters). Thus old arguments against CMB emission from individual sources become meaningless in view of straight SUM.

Here is, however, no horizon concerning the infinite universe as a whole. Stationary features, directly observable instead, may include some fiducial lengths to explain the CMB anisotropies. In any case this chance seems also to imply acoustic hDM oscillations which are understood to arise from the interplay of gravitational attraction against the pressure of dark matter and that of radiation again.

Though such acoustic oscillations are easily conceivable within voids, there cannot be an unnecessary consistent phase coherence of fluctuations all over the infinite universe. If it were not for several peculiarities like in particular the low-multipole alignments [Schwarz, Copi, Huterer, & Starkman 2015] ('axis of evil'), a hemispherical power asymmetry or e.g. the strange 'cold spot', it might seem an unreasonable attempt to question the assumed single-bang origin of the CMB and thereby the exceptionally successful inflationary ΛCDM cosmology (but also some more fundamental problems must not be forgotten).

Any structure at a universal ('comoving') distance of about 70 times its diameter is observed at about a scale angle of 0.8° on the sky, as might roughly apply from e.g. galaxy halos (order 80 kpc) at cluster distances, up to large voids (order 60 Mpc) at Hubble distance $R_H \equiv c/H$, or particularly from cluster distances themselves (order 6 Mpc) in the transition zone to universal homogeneity at $Z \approx 0.1$ (order 400 Mpc). Accordingly the anisotropies of the temperature distribution in the microwave background may be caused by acoustic hDM oscillations in voids or also by the well-accepted existence of resolvable iDM halos. Analogously to ΛCDM cosmology – though the other way round – also an appropriate SUM transfer function will contain information including a set of quite a few adjustable parameters relating the CMB as actually observed to the distributions of luminous and 'dark' matter. The chance for a corresponding explanation of the CMB anisotropies as correlated to e.g. baryon acoustic peaks [Eisenstein et al. 2005] seems almost evident by taking a glance at Fig. 14-e of Sharp [1986] if compared to Fig. 7 of Bennett et al. [2003]. This will need detailed further investigations.

The difference between both kinds of dark matter does not necessarily mean different particles, since the possibility of whether or not lumping together might correspond to a different behaviour of e.g. thermalized or non-thermalized neutrinos. Therefore again, the whole microwave background has to be newly considered without ΛCDM priors. Otherwise, measuring a redshift dependence of the CMB monopole temperature using the tSZ effect in the CCM framework [de Martino et al. 2012], [Luzzi et al. 2015] does mean little or can be even misleading. The CCM-assumed development of the CMB monopole temperature seems as questionable as the assumed temporal development of universal iron content from population III to population I stars (s. remarks in Section 2.7).

Corresponding results as reported by e.g. Noterdaeme et al. [2011] have to be reviewed particularly in view of the strange Planck spectrum $\rho^*_Z$ observed from behind distant clusters at a comparatively reduced temperature $\Theta_Z = \Theta_{\mathrm{hDM}}/(1+Z)$ as found in (73) above.

In this subsection, however, the intention has been primarily to show that the SUM would be well compatible to the existence of a universal BB background. In contrast to historical attempts (e.g. in the SST), now with the redshift fully taken into account, a hDM radiation as discussed here seems to provide the only arguable alternative describing a CMB origin within the universe.

It may be remarked, without claiming a realistic chance, that if dark matter was built of thermalized neutrinos, a preliminary assessment on base of relation (79) would yield about 10 locally emitted hDM photons a year within a 1000-m$^3$ tank (in rough order of magnitude; where such a detector would have to be cooled below 2.7K inside).

## 6 THE PLANCK 2015 MODEL PREDICTION MISMATCH OF SUNYAEV-ZELDOVICH CLUSTER COUNTS

The PLANCK 2015 model predictions do not match the observed Sunyaev-Zeldovich cluster counts well. The discrepancy increasing towards lower signal-to-noise thresholds suggests that the data favour a steeper slope. The question is whether this behaviour could be in better agreement with the alternative Planck microwave background which according to the previous section is mathematically composed of redshifted radiation from homogeneous 'dark' matter within a stationary universe. The SZE amplitude would appear continuously reduced to higher values of $z$ due to an absorption constant $\kappa$=2 in the mm range.

Though increasingly weakened with redshift, however, the modified effect would stay present in any hot-gas cluster due to full local CMB, while a gradual shift of the SZ spectral profile to lower frequencies seems ruled out at first sight. But with respect to the subtraction of unavoidable noise and various 'foregrounds', a definite clarification turns out to be more difficult than expected.

The bold black line on top of Figure 7(a) shows the total CMB spectrum as actually observed (the vertical dashed lines mark the nine PLANCK frequencies), while thin red

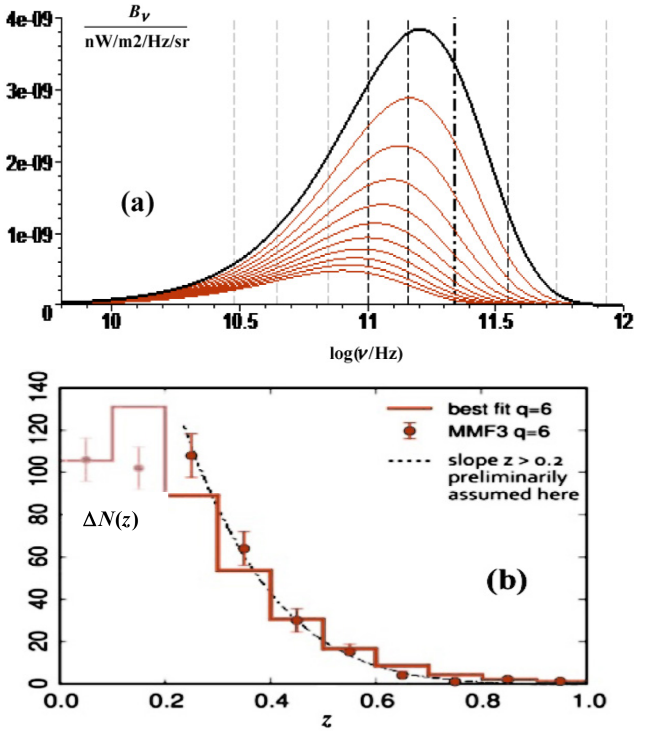

FIGURE 7. – *Upper panel* (a): The CMB parts $\rho^*_Z$ (73) coming from behind $z = Z$ according to SUM [in contrast to Figure 6 thin curved red lines here top down for $Z$ = 0.1, 0.2, .. 1.0] – L*ower panel* (b): the PLANCK "$q$=6" SZ cluster counts (excerpt from Fig.4 of [Ade et al. 2015/XXIV] with an assumed slope at $z$ > 0.2 added for illustration), where a systematic mismatch appears down from the 3rd redshift bin.

solid lines show top down respective parts of the universal hDM radiation coming from behind $Z = 0.1, 0.2, \ldots 1.0$ statistically. These parts $\rho_Z$* decrease with distance according to relation (73). The other way round, by far most of the BB radiation reaching telescopes would have been emitted within $Z < 1$. In Figure 7(b) the curved dashed black line is added for illustration to the PLANCK-2015 model prediction mismatch of Sunyaev-Zeldovich cluster counts, completely unexpected in high precision ΛCDM cosmology.

## 6.1 The isolated thermal SZ effect in the SUM framework

A pure Sunyaev-Zeldovich effect from a 'dark' matter microwave background, according to SUM composed of redshifted universal radiation, may be briefly discussed at first. In each cluster the full local CMB radiation is subject to inverse Compton scattering. According to (68), (73) all particular clusters may be regarded as local 'sources' of the SZE signal at respective redshift $Z$. With respect to Section 5 the SUM counterpart to the well-known traditional SZE should appear increasingly reduced at high redshifts according to

$$\Delta I^{\rm SZ}_{\rm SUM} = I_0\, y\, \frac{g(x_{\rm E})}{(1+Z)^3}\ , \tag{83}$$

where $y$ is correlated as usual to cluster masses (often unknown), and $g(x_{\rm E})$ arises from

$$g(x) \equiv \varepsilon(x)\cdot f(x) \equiv \frac{x^4 e^x}{\left(e^x-1\right)^2}\cdot\left[x\coth\!\left(\frac{x}{2}\right)-4\right] \tag{84}$$

after replacing $x$ by $x_{\rm E} \equiv h\nu_{\rm E}/(k\Theta_{\rm hDM}) \equiv h\nu(1{+}z)/(k\Theta_{\rm hDM})$. Regarding the PLANCK results as well as previous measurements [Vanderlinde et al. 2010], however, frequency shifts according to (83) seem to have been ruled out. Corresponding modifications are exemplarily shown in Figures 8(a)-(d) for $y = 10^{-4}$.

Like in ΛCDM cosmology a temperature $\Theta$ of radiation coming from behind $Z$ is observed at $\Theta_Z/(1{+}Z)$; the difference is, that here $\Theta_Z = \Theta_{\rm CMB} = \mathit{constant}$ (= $\Theta_{\rm hDM}$). According to the tentative approach above, the total hDM radiation of macroscopically non lensing sources is constituting the SUM Planck spectrum statistically. Hence the green solid lines in Figure 8 should be considered as isolated pure thermal SZ effects at first. In contrast to the ΛCDM cosmology, however, additional 'primordial' microwave inhomogeneities will also arise between cluster and observer.

## 6.2 The realistic SZ effect among other CMB distortions

From relations (70), (71), the SUM contribution of one spherical shell to the CMB blackbody spectrum is

$$\Delta\rho^*_{{\rm hDM}\,\nu} = Y\int_Z^{Z+\Delta Z} \varepsilon(x_{\rm E})\,(1{+}z)^{-2-\kappa}\,{\rm d}z \approx Y\frac{x^4\, e^{x_{\rm E}}}{(e^{x_{\rm E}}-1)^2}\,\Delta Z \tag{85}$$

what thus may imply isothermal fluctuations of order $10^{-4}$ within approximately 100 kpc. It is remarkable that for $z$ = 0 the integrand of (70), (74), or (85), which leads to the observed CMB Planck spectrum, equals the well-known SZ-factor $\varepsilon(x)$ of $g(x)$ in (84) exactly.

Therefore a more complete spectral distortion of the microwave background according to SUM may be written as

$$\frac{\Delta I_{\rm SUM}}{I_0} = y\,\frac{g(x_{\rm E})}{(1+Z)^3} + X_{\rm back}\,\varepsilon(x_{\rm E}) + X_{\rm fore}\,\varepsilon(x_{\rm fore})\ , \tag{86}$$

since given a CMB origin within the universe *one has to discern between inhomogeneities in the 'back'-ground and those in the 'fore'-ground* of any SZ-clusters. It is important to realise, that the latter may compensate the SUM frequency shift in parts as shown in Figure 9(b), for example.

It may be remarked that the assumed redshift $Z$ = 0.6 of Figures 8(b), 9(b) corresponds only coincidentally to that

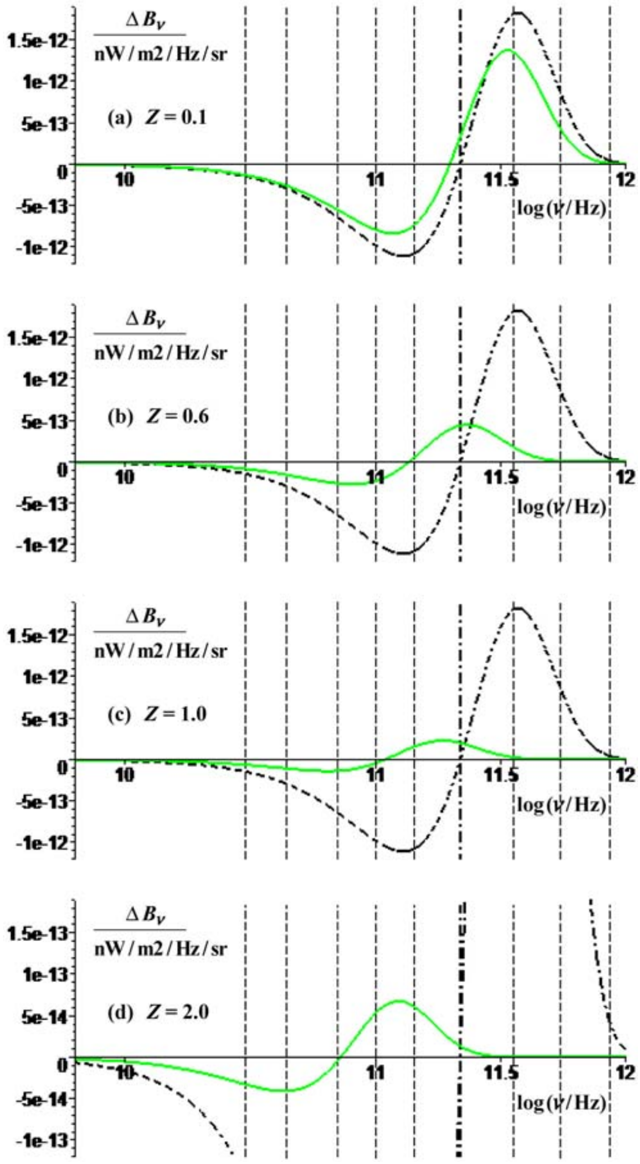

FIGURE 8. – The curved green lines show the isolated thermal SZ-SUM effect $\Delta B_\nu$ with spectral function $g(x_E) = x_E^4 e^{x_E}[x_E \coth(x_E/2)-4]/(e^{x_E}-1)^2$ shifted according to $\Theta_Z = \Theta_{hDM}/(1+Z)$ of radiation from behind (a) $Z = 0.1$, (b) $Z = 0.6$, (c) $Z = 1.0$, (d) $Z = 2.0$ without any additional inhomogeneities. The respective curved dashed black line in all panels (a) - (d) indicate the SZE as expected in ΛCDM cosmology [note that the vertical scale in panel (d) is reduced by a factor of ten].

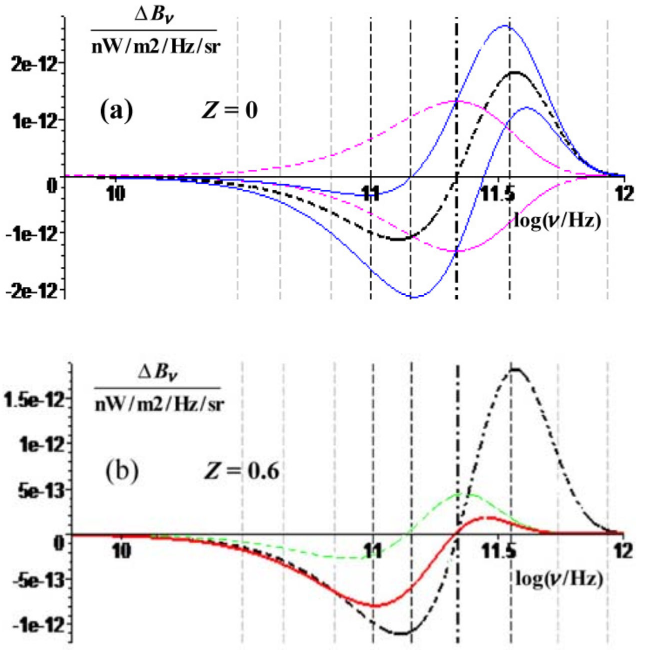

FIGURE 9. – *Upper panel* (a): Isothermal CMB fluctuations of order $y \approx 10^{-4}$ are plotted in red, while the thin curved blue lines show changes of the local SZE. – *Lower panel* (b): As stated by relation (86) this highly important figure demonstrates a possibly resulting realistic SZ signal as bold red line ($X_{back} \approx -5 \cdot 10^{-5}$) where SUM's isolated frequency shift according to the broken green line [s. also Figure 8(b)] seems largely compensated by such a random *'back'-ground* inhomogeneity (lower intensities might be understood as lower $y$'s).

of SPT-CL J2344–4243 (Phoenix Cluster, the most X-ray luminous cluster known in the universe, whose SZE has been detected with a signal-to-noise ratio (SNR) of $\xi$ = 27.44 in the SPT-SZ Survey [Bleem et al. 2015], while a SNR-value of $\xi$ = 6.73 is given in the PLANCK data psz1v2_1). It has to be noted, too, that any resolvable contribution of the additional CIB if observed e.g. from this Phoenix Cluster, may not be resolvable if observed from the solar system. No doubt that there is a plenty of corresponding distant point sources. As well, any exact distinction between the CMB and CIB can hardly make a clear sense [SUM14] particularly in the overlapping frequency range, where the CIB contributions do not completely vanish at all [Hauser & Dwek 2001], [Kashlinsky 2005].

The second summand in (86) corresponds formally to a *kinematic* SZ effect in the SUM framework. Here, however, not only the numerical modification is of interest but also the contribution of the low-*z* environment to the 'local part' of the CMB, which might raise questions particularly in the context of an assumed 'dark flow' [Kashlinsky, Atrio-Barandela, & Ebeling 2012].

Originally, the aim of SZ cluster surveys has been to detect previously unknown galaxy clusters via the thermal SZ (tSZ) effect at frequencies mostly below 218 GHz. Now the PLANCK data encompass nine frequencies (s. vertical broken lines in Figures 6 - 9). At frequencies from 353 GHz, however, the radiation is increasingly dominated by galactic and extragalactic emission as stated in PLANCK-XXIII [Ade et al. 2015]. In the 220 GHz SPT-SZ maps the relative noise levels were found too high to significantly improve cluster detection [Bleem et al. 2015].

Correspondingly cluster searches have been mostly relying on smaller frequencies before. Since SZ-measurements in the bands ≥ 218 GHz are particularly problematic, in view of unknown individual masses or re-shifting CMB inhomogeneities these seem to make no clear differences between both alternatives of the tSZ particularly in count ranges $z < 1$. So it cannot be safely excluded, that actually the PLANCK 15 model prediction mismatch might partially arise from a correspondingly reduced signal-to-noise ratio. PLANCK's major objectives – encompassing tests for theories of inflation and providing a direct probe into the Concordance Model's initial inhomogeneities – have been exclusively focused on the ΛCDM cosmology so far.

In accordance with Figure 8, using frequency bands respectively up to 143 GHz, 100 GHz, 70 GHz, 44 GHz, or 30 GHz, a SUM cluster search should straightforwardly apply up to $Z \approx 0.5$, $Z \approx 1$, $Z \approx 2$, $Z \approx 3$, $Z \approx 5$ even without any re-shifting inhomogeneity in spite of SUM's SZ frequency shift increasing with $Z$.

Actually without taking any additional inhomogeneities into account, the SUM-SZE would stay definitely detectable also at e.g. $Z = 1.9$ (XLSSU J0217–0345) using the same 30 GHz band as in [Mantz et al. 2014]. This can be seen from the lowest panel (d) of Figure 8 (where the vertical scale is reduced by a factor ten).

So far, primarily clusters showing a SZ signal as assumed in ΛCDM cosmology were found best of course. Anyway, however, also the risk of another significant selection bias has to be taken into consideration [Rossetti et al 2015]. Particularly in view of the PLANCK 2015 cluster count prediction mismatch it appears doubtful whether the data can be fully explained without ascribing any more *ad-hoc* features to the 'big bang' universe.

Taken together, the alternative CMB solution requires an attenuation $1/(1+z)^2$ of intensity in the mm range (due to $\kappa = 2$ in addition to the usual photon energy loss by redshift). It is obvious that a gradual reduction of the SZ intensity (in total up to about 15% the value expected for clusters at $z = 1$) should in any case lead to a steeper 'q = 6' slope in the PLANCK 2015 prediction down from the 3rd redshift bin as illustrated in Figure 7(b) above, while other 'free' parameters might be adjustable to match the absolute values of the first and second redshift bin, too.

This tentative SUM approach to the microwave background should be testable in particular by solution of the PLANCK 2015 SZ model prediction mismatch as discussed here. Such a test, however, can only convincingly work by a future evaluation without any hypothetical ΛCDM priors, but in the SUM framework this time [Battistelli et al. 2016]. The other way round, to further confirm the CCM once more it would be important to demonstrate – just because of far-reaching consequences – that the alternative CMB model of SUM will definitely prove incompatible with safe observational facts of the SZ effect.

Nevertheless, even if the approach tried in this section will turn out to be a wrong track, it had to be attempted for the sake of a possibly final clarification.

## 7 DISCUSSION AND CONCLUSION

Fundamental facts which are well-known as main pillars seem to prove 'big bang' cosmology beyond all doubt. Almost as strong as those pillars, however, as weak seems some ground. – In addition to

(a) a scalar inflaton field, in experiments never observed, necessary to solve the problems of spatial flatness and unacceptable horizons among other difficulties,

(b) 'anthropic' features, which need an effective fine tuning of big-bang cosmology, in particular concerning the assumed strange coincidental 'age of the universe' equalling the Hubble time just only today,

(c) an *imperfect* cosmological principle excluding time from universal symmetry,

(d) above all the baryon asymmetry which means an unexplainable 'big bang' matter-antimatter discrepancy contradicting an assumed origin either from nothing or from vacuum fluctuations which are not represented by any known line element of Einstein's equations (in contrast to that of SUM).

Historically these unexplained features of the current ΛCDM cosmology may have been widely accepted in view of apparently no arguable alternative so far.

Only the stationary line element (4) is, effectively in form of one 'multiverse', providing the chance for an appropriate relativistic counterpart to the otherwise mysterious background. In this framework, several particular problems seem to disappear or, at least, are seen in different light. Twelve of them have been explicitly addressed in the various sections of the paper on hand.

– *The problem of cosmic redshift and universal expansion:* The universal redshift is deducible as gravitational effect without the need for any corresponding motion. An assumed quasi-Doppler redshift, however, if interpreted as universal expansion, would inevitably mean a "schism of consistent physics" (particularly where superluminal). This because of two different velocities between same physical objects which would apply to e.g. our Milky Way and a distant galaxy in 'Hubble flow' with some additional peculiar motion (Section 2.5).

– *The problem of an ignored significant Hubble constant:* This difficulty is clearly associated to a traceably mistaken Hubble parameter which is erroneously related to 'proper' distances, while only with respect to 'comoving' coordinates, galaxies are statistically at rest. An unlimited preference, however, of 'proper' length over universal ('comoving') distances is found inappropriate. As shown in Section 2.7 it is impossible to apply the SRT concepts of proper quantities to distances $r^* > R_H$. The other way round, the time independence of both the Hubble constant and redshift obviously proves stationarity again.

– *The problem of FLRW cosmologies:* The Friedman(n)-Lemaître-Robertson-Walker line element – if as usual mistaking its coordinate time for an assumed universal 'proper' time – is ignoring the intrinsic limitations of SRT quantities bound to local inertial systems (Section 2.4).

– *The problem of one singular 'big bang':* This dilemma would vanish in case of multiple *local* bangs within one all-embracing background universe, where no unexplainable features of ΛCDM cosmology had to apply at the whole. Unchanging laws of nature would be a miracle after a singular origin of space and time out of nothing – leading incomprehensibly from blind chaos to fixed physical laws – whereas this feature is self-evident in a stationary universe, s. Section 2.8 and Appendix A (the unnecessarily assumed incompatibility of general relativity with quantum mechanics is also addressed there).

– *The problem of dark matter:* Thinking free of the ΛCDM 'big bang' paradigm, there are several widely ignored chances of 'dark' matter. So far such a substance means only its inhomogeneous part with an alleged mysterious lack of physical interaction except for gravitation (Section 4.1). The number of 24 elementary spin-½ particles, possibly related to the 24 components of a real torsion tensor, is briefly discussed in this context (Section 4.3). In case that some frequency ranges of gravitational waves should partially escape direct measurements, it might lead to the conclusion that these are absorbed to some extent by dark matter in parts near the respective places of emission; so they would possibly not reach terrestrial detectors in the expected form [s. also Shannon et al. 2015].

– *The problem of 'dark energy':* This CCM feature is irritating fundamentally. Based on SUM's stationary magnitude-redshift relation, however, a homogeneously distributed main part of non-lensing dark matter instead of 'dark energy' explains the Supernovae Ia data straightforwardly on universal scales (Section 4.2). In addition, such an optically almost transparent distribution may fill the gap between observable matter and the critical density. Thus also in this regard, homogeneous dark matter is accounting once more for what is ascribed to 'dark energy' today.

– *The problem of two different values for the CCM Hubble 'constant' $H_0$:* Within high precision standard cosmology also the dilemma of two confirmed but different Hubble values $H_0$ (s. Section 3.2) proves a deep flaw in their interpretation, and thus of the whole ΛCDM concept. It is obvious from the SNe-Ia measurements that these data can be only explained either by the SUM taking into account a local Hubble contrast (within $z < 0.1$) or by the CCM requiring a mysterious 'dark energy' due to a cosmological constant (unexpected by impossible orders of magnitude).

– *The problem of the microwave radiation background:* In view of the low-multipole alignments and a Sunyaev-Zeldovich cluster count prediction mismatch – both hardly explainable in the CCM framework – or other measurements indicating a possible break down of standard cosmology, most of the CMB might be emitted from the homogeneously distributed part of dark matter within the universe (Section 5). Its inhomogeneities and anisotropies seem to reflect – similarly to the assumptions in the ΛCDM model – acoustic oscillations at a statistical mean constant universal temperature. Concerning both SZ effects, also the results of Lieu, Mittaz, & Zhang [2006], or a 'dark flow' reported by Kashlinsky, Atrio-Barandela, & Ebeling [2012], had already raised doubts in the 'big bang' origin of this radiation. According to SUM it is assumed to be only a special part of extragalactic background light. Corresponding numerical SZ modifications primarily in the high-$z$ range have been derived in Section 6. Taking into account the natural DM inhomogeneities, there is apparently no clean SZE except for many clusters at $z \ll 1$ (like e.g. Abell 2319 at $z = 0.056$ whose multi-band observations are shown on ESA's web page exemplarily). Selected low-redshift clusters, however, prove the existence of such an effect not only in ΛCDM cosmology but in the SUM framework as well. Therefore an extensive exploration without CCM priors may be actually justified in particular with the plenty of PLANCK data available now. Whatever results, it seems worthwhile to check – or finally exclude – the unexpected SUM alternative, which would prove a CMB origin within a stationary universe.

– *The problem of a non-resolvable part of the CIB:* The existence of the CIB in addition to what is commonly called the CMB, means that in view of the CCM there are two essentially different contributions, where the overlapping CIB part is merely discerned by the presupposition of a 'big-bang' relic radiation based on hypothetical phases of 'inflation', 're-combination', and 're-ionization'. From the perspective of SUM, however, the CMB on the one hand and the mm-parts of CIB on the other hand are of necessarily related origin. Today, the latter seem only subsequently defined to be what remains after subtraction of a theoretical black-body fraction from the actually measured extragalactic microwave background (Section 4.2).

– *The problem of a universal CMB restframe:* This contradicts relativity theory's historical axiomatic presupposition of no preferred frame. The other way round, it is of fundamental importance to determine a 'restframe' in general with respect to ultra-large scales. The reality of the universal frame is strongly supported by redshift values statistically independent of time (Appendix B).

– *The problem of entropy:* An inevitable increase of entropy can be only observed in evolutionary environments (Appendix C.3.1). Therefore the second law of thermodynamics may be restricted to processes outside multiple 'local bangs' – without conflict with any laboratory experience – thus allowing for 'primordial' nucleosynthesis in re-creation processes possibly associated to AGNi or GRBs.

– *The problem of nonsensical 'parallel universes':* If there existed separated 'parallel universes', their entirety could not be described by today's mathematically coherent CCM. In a valid physical solution of Einstein's equations, however, if completed by a detailed quantum energy-momentum tensor of matter, neither physical singularities nor universal horizons must exist. Thus instead of one singular 'big bang', SUM rather suggests a multiverse of *local* 'cosmoses'. In this view there can be no ultimate fate for the universe (Section 2.8, Appendix C.3.3). Not at all will the universe end up in bleak emptiness.

All of the problems above are far from being solved in ΛCDM single-bang cosmology, which instead seems only got used to them. In consequence, there is a serious risk to accept even more unphysical hypotheses to escape any new dilemma of unwelcome future results.

A brief clearance based on Poincaré's considerations – accepted in *'Geometrie und Erfahrung'* by Einstein [1921] himself – shows non-Euclidean geometry as the mathematical tool to handle affectable 'proper' rods and clocks (Appendix C.3.2). This approach seems to offer a solution in principle of two main problems of 20th century physics (as discussed in Appendix A).

In view of SUM, important CCM features resorting to peculiar phases in the assumed history of the universe have to be alternatively explained by selection effects – including Malmquist biases together with various forms of attenuation – or by 'local' cosmic evolution possibly with peculiar flows. For example, the observed distributions of quasars or Lyman-α blobs are addressed in Appendix C.3.

Thus the chances for reconciling unexpected results with SUM cannot be excluded, even if originally achieved in the framework of big-bang cosmology, quite the contrary. Essential processes in the lively universe are not understood completely. The SNe-Ia breakthrough at the turn to the 21st century will hardly remain the last unexpected cosmological discovery forever.

Summarizing several fundamental observational facts in approximate accordance – or at least not definitely in conflict – with the SUM results derived in the deductive part of this paper (Section 2), it seems a legitimate conclusion that relativistic cosmology may have gained future scope between two extreme alternatives: a singular CCM origin of the whole universe including space and time on the one hand or, on the other hand, a SUM background including local quasi-bang events within one multiverse. This paper claims that, what today's standard cosmology describes as an unevenly evolving evolutionary cosmos, cannot be – or in no case has necessarily to be – the entire universe.

Even if SUM was able to describe the universe straightforwardly, however, it could not be expected to explain the plenty of cosmological observations at once. These have been implemented step by step into the 'big-bang' cosmology by various modifications. Many open questions should be answered in the new context, whether positive or negative, as this has happened with many open questions in the past. Correspondingly several unbiased attempts will be needed to provide future clarification.

Regarding clarity and symmetry, the SUM seems appropriate to describe the entire universe, whereas the CCM would rather describe our evolutionary cosmos, if at all. Even the criterion of aesthetics is of some practical importance, since for an unbiased comparability it is reasonable (or even necessary), to refer to the simplest model which allows an unambiguous systematic classification of observational data. In this view, the SUM might be actually predestined as a reference model because of its unique mathematical simplicity.

Finally, according to Occam's law of parsimony ('Occam's razor'), it is a proven intellectual requirement as well as a scientific obligation to select among competing models the one with the fewest unprovable assumptions (an overview in Table 1 below may give some hints).

If Einstein's original equations had been accepted *without* his 'biggest blunder' of a cosmological constant, then the SNe-Ia measurements would have confirmed SUM straightforwardly. A brief historical review together with some remarks on the underlying concept, its origin and related earlier attempts is given in Appendix C.4.

In any case it is no longer possible to take the sheer existence of a black-body microwave background radiation as a certain proof for a big-bang origin of the universe.

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## APPENDIX A: FIXATION OF ROSEN'S BI-METRIC RELATIVITY TO THE UNIVERSAL FRAME

A natural approach [SUM14] to Einstein's non-Euclidean line element yields not only GRT's fundamental tensor $g_{ik} = e_{ai}\, e^a{}_k$ which enables to effectively establish a non-Euclidean geometry of affected rods and clocks but, at the same time, leads immediately to the only appropriate form to apply GRT to e.g. half-spin particles governed by the Dirac equation. This form and its mathematical features are well-known as Einstein's *vierbein* or *tetrad* representation [Einstein 1928], [Landau & Lifschitz 1992]. In addition, Rosen [1963] has pointed out an assumed link between his bi-metric formulation of GRT and this tetrad representation, which suggestion will be realized now.

Retrospectively, Einstein's theories are mathematically based on the well-known fundamental tensors $\eta_{\mathrm{ab}}$ of SRT and $g_{ik}$ of GRT, where the indices $a, b .. = 1..4$ refer to the first, while as usual the indices $i, k.. = 1..4$ refer to the second. Now the 'non-Euclidean' $g_{ik}$ will be derived, where – in contrast to the quasi-Euclidean *coordinates* $x^a$ of flat space and uniform time – the arbitrary coordinates $x^i$ may refer to any mathematically acceptable system. – Given two neighbouring points $\mathrm{P}(x^a)$ and $\mathrm{Q}(x^a{+}\mathrm{d}x^a)$ in a quasi-Euclidean 'spacetime' of SRT as represented by the Poincaré group, their 'proper' distance from an arbitrarily chosen origin measured with spectral rods and atomic clocks, both affectable by gravitation or motion, will be

$$\sigma^a_{\mathrm{P}} = x^a + \xi^a(x^a), \tag{A1}$$

$$\sigma^a_{\mathrm{Q}} = (x^a + \mathrm{d}x^a) + \xi^a(x^a + \mathrm{d}x^a), \tag{A2}$$

where the function $\xi^a$ is describing the respective deviation from the non-affected value $x^a$ due to physical deformation of the measuring tools. Now the second summand of $s_{\mathrm{Q}}{}^a$ may be expanded according to

$$\xi^a\left(x^a + \mathrm{d}x^a\right) = \xi^a\left(x^a\right) + \left[\partial_b \xi^a\right]\left(x^a\right)\mathrm{d}x^b + \ldots \tag{A3}$$

with $\partial_b \equiv \partial/\partial x^b$ and, for the sake of readability, the designator $(x^a)$ will be hereafter omitted. The expansion (A3) yields the 'properly' measurable infinitesimal interval

$$\mathrm{d}\sigma^a \equiv \sigma^a_{\mathrm{Q}} - \sigma^a_{\mathrm{P}} = \mathrm{d}x^a + \left(\partial_b \xi^a\right)\mathrm{d}x^b + \ldots \tag{A4}$$

between the two neighbouring points Q and P. Here it is decisive to assign *by definition* a mixed tensor $\xi^a{}_i$ according to the second identity of the following expression

$$\mathrm{d}\xi^a \equiv \left(\partial_b \xi^a\right)\mathrm{d}x^b + \ldots \equiv \xi^a{}_i\,\mathrm{d}x^i, \tag{A5}$$

where $\xi^a{}_i$ and $\mathrm{d}x^i$ are not only applicable with respect to the quasi-Euclidean coordinate system above, but with respect to any additional set of arbitrary coordinates $x^i$ as well. Because of the '…'-symbol it is

$$\xi^a{}_i \not\equiv \partial_i \xi^a \tag{A6}$$

*in general* (GRT), while otherwise this would lead to a *special* case (SRT). According to (A5), relation (A4) may be written as

$$\mathrm{d}\sigma^a \equiv \mathrm{d}x^a + \mathrm{d}\xi^a \equiv e^a{}_i\,\mathrm{d}x^i, \tag{A7}$$

where

$$e^a{}_i \equiv \partial_i x^a + \xi^a{}_i\,. \tag{A8}$$

As usual, there may be defined the covariant SRT 4-vector $\mathrm{d}\sigma_a$ by lowering an index $b$ using the $\eta_{ab}$, what is equivalent *by definition* again to the second identity in

$$\mathrm{d}\sigma_a \equiv \eta_{ab}\,\mathrm{d}\sigma^b \equiv e_{ai}\,\mathrm{d}x^i. \tag{A9}$$

The square of the line element, $\mathrm{d}\sigma^2 \equiv \mathrm{d}\sigma_a \mathrm{d}\sigma^a$, follows by direct multiplication from (A9) and (A7) in the form underlying the mathematics of GRT

$$\mathrm{d}\sigma^2 \equiv g_{ik}\,\mathrm{d}x^i\,\mathrm{d}x^k, \tag{A10}$$

where finally, as easily seen,

$$g_{ik} \equiv e_{ai}\,e^a{}_k\,. \tag{A11}$$

No property of space and time is used in this derivation but merely a 'deformability' by gravitation and motion of physical rods and clocks (where universal motion is defined with respect to the coordinates of the stationary gravitational potential according to Section 2.1).

A feature immediately stated in [Einstein 1928] may support this claim: In general 16 components of $e^a{}_i$ determine the 10 components of $g_{ik}$ uniquely, while the other way round the fundamental tensor does not fix the tetrad completely. Therefore Einstein tried to find field equations to determine all of its components, too. In view of the SUM concept, however, such an attempt seems pointless. The existence of remaining 6 free parameters is necessary to allow for 4-dimensional rotation of particles (also including Newton's bucket) within the (quasi-)Euclidean universal frame without changing the physical implications of the non-Euclidean 'metric' $g_{ik}$. The tetrads will always allow transformations of the arbitrary coordinates $x^i$, $x^k$ to result in $g_{ik} \rightarrow \eta_{ik}$ locally.

It seems reasonable, to explicitly emphasize the fact that respectively one index (e.g. $a$, $b$ …) of any appropriately chosen local tetrad does represent the preferred universal frame, where however an arbitrary constant rotational orientation of the respective coordinate system remains freely choosable as it must be. Going beyond Riemannian geometry as the mathematical apparatus of conventional GRT this approach clearly allows to take torsion into account (s. also Section 4.3).

The physical meaning of the tetrads is obvious from relation (A7) which connects respective infinitesimal coordinate intervals $\mathrm{d}x^i$ of GRT to corresponding elements of 'non-Euclidean' proper distances $\mathrm{d}\sigma^a$ (where 'non-Euclidean' does mean nothing but the fact that the infinitesimal distances $\mathrm{d}\sigma^a$ are only measurable with gravitationally affected rods and clocks).

The completion of what is called 'general relativistic spacetime' by the quasi-Euclidean universal frame, at any arbitrarily choosable reference point $t^*_\mathrm{R} = 0$ of universal time, as here definitely implied in the tetrad concept – after reflected in Rosen's bi-metric approach – now may offer a solution in principle of two main problems of 20th century physics: the alleged incompatibility of GR with QM as well as an assumed unphysical 'big bang' creation of space and time out of nothing.

In addition, it might be anything but coincidental again that the concept of angular momentum, going beyond the strict general relativistic approach, is closely related to the indirect observation of gravitational waves from decreasing periods of binaries (as well as in another context to the Einstein, Podolsky, & Rosen paradox [1935] concerning the spin of entangled particles, too).

Now that the legitimacy has been explicitly shown here to understand spatial 'curvature' a gravitational effect on measuring rods instead on mathematical space, the latter therefore can be taken Euclidean at all events. According to SUM, the universal coordinates are only a special representation of what is called 'system coordinates' in GRT.

On the other hand, to understand the concepts of 'proper' length and 'proper' time as cool as possible – in fact without any loss of physical content – it is sufficient to accept the existence of a 'preferred' universal frame as stated in Appendix B. This is not only possible, but in view of various well-known observations physically realistic.

With regard to a unique universal frame, however, there is no longer a need to speak of 'pseudo'-tensors and 'pseudo'-tensor densities of the gravitational field, but rather of true bi-tensors and bi-tensor densities now. The transformation properties of such quantities and the mathematical foundations for the transition from a preferred frame to an arbitrary other one is provided by Rosen's bi-metric formulation [1940, 1963] of GRT on basis of a mathematical ansatz made by Levi-Civita [1926] (Rosen's reformulation called 'bi-metric relativity', however, must not be confused with his outdated deviating 'bi-metric theory' later on, see Will [1993] with references therein).

According to Rosen's approach, in view of the SUM it is sufficient first to apply Einstein's equations as well as all tensors or 'pseudo'-tensors with respect to the universal frame in their familiar form. Then, for a transition to any other coordinates, all ordinary derivations – even occurring as parts of the Christoffel symbols or of any covariant derivatives in the GRT framework – have to be afterwards replaced by a second kind of covariant derivations, now with respect to the new coordinate system. In addition, the negative determinant $g$ of the fundamental tensor $g_{ik}$ has to be replaced by $g/\gamma$ where here $\gamma$ is the negative determinant of $\eta_{ik}$ after both tensors are transformed to the new coordinates [for example $\eta_{ik} = \mathrm{diag}(1, -1, -r^2 \sin^2\vartheta, -r^2)$ in spherical coordinates].

Only on this base, the energy content of the gravitational field does no longer depend on the respectively chosen coordinate system. It is only this feature that would guarantee an objective reality of any energy transport within gravitational fields, in particular that of gravitational waves (whether these are directly detectable or not).

While Rosen has convincingly shown that applying GRT it is possible and of important advantage to refer to a second metric [(bi-)] of 'flat space', it may be emphasized here, that such a treatment is not only a chance but even a need, because: From all claims in the framework of GRT it is exactly that of a general covariance in choosing arbitrary coordinate systems, which forces to treat the so called pseudo-tensor as a true bi-tensor with respect to the universal frame. Only in this way it is possible to describe the processes leading to decreasing orbital periods of binary pulsars independently of the coordinates used there. This procedure even works if one might chose an appropriately rotating flexible coordinate system where the binaries would be at rest all the time (s. Appendix B).

It is anything but coincidental – though apparently disconcerting Einstein for a while – that the mathematical description of spinning objects needs mathematics going beyond pure Riemannian geometry.

For instance, in the historical framework of GRT it is even impossible only to *define* a tensor density of angular momentum $\mathbf{M}^{\alpha\beta} = \int (x^\alpha \mathbf{V}^{\beta 0} - x^\beta \mathbf{V}^{\alpha 0})\,\mathrm{d}x^3$ consistently because of the missing 4-vector or 4-tensor properties of the coordinates $x^i$ and of the densities $\mathbf{V}^{ik}$. In consequence a corresponding conservation law could be only of limited validity according to local SRT. This would also forbid to make up an exact balance in total for various distant observers of the changing angular moment of e.g. the binary pulsar PSR 1913+16 and their own galactic environments.

The simplest reason for such an inconsistency in the framework of conventional GRT is that in the well-known SRT definition if transferred to GR, spatial non-proper coordinates will be necessarily involved [RKQ08/V]. Already the statement of a universal (non-local) angular momentum conservation law is tacitly presupposing a preferred frame and consequently the use of Rosen's bi-metric relativity. Furthermore the symmetry of a total EMS tensor $V^{ik}$ of matter *and* gravitational field has to be claimed, which would imply a necessary symmetry of $t^{ik}$ itself. According to conventional understanding, in $V^{ik} \equiv T^{ik}+t^{ik}$ a true GR tensor had to be added to a mere 'pseudo' tensor, the latter essentially depending on the respective coordinate choice so far.

Strictly speaking, the validity of a universal conservation law for angular momentum is already sufficient to disprove the claim to absoluteness of the historical geometric 'spacetime' approach. In that conventional GRT refers exclusively to what is called *proper* quantities, it is dogmatically adhering to a pure geometric conception which would unrealistically require non-affectable standard units. GR by itself, however, cannot work without QM if applied to processes going beyond the 'geodesic' equations of motion (the latter attribute only reflects the important geometric analogy, s. also [Weinberg 1972]).

The alleged incompatibility of GR and QM merely exists within the unnecessary geometric concept of a physical 'spacetime'. What actually is missing, however, are valid solutions of relation (59) in universal coordinates instead. There may be no other chance for a 'theory of everything' than an identical fulfilment of (59) which seems to be unattainable, though, because it would have to apply in all to the entire universe. This means that an ideal ultimate line element – internally including tetrads as manifestations of also quasi-Galilean space and time – would have to cover strong, weak, and electromagnetic interaction, which concepts in spite of the standard model of particle physics are still incompletely described today.

As indicated above, the appropriate form to apply general relativity to half-spin particles, governed by the Dirac equation, requires the fulfilment of relation

$$\tfrac{1}{2}\left(\hat{\gamma}_\mu \hat{\gamma}_\nu + \hat{\gamma}_\nu \hat{\gamma}_\mu\right) = g_{\mu\nu} \equiv e_{a\mu} e^{\alpha}_{\ \nu} \tag{A12}$$

for modified spin matrices $\hat{\gamma}_\mu$ in extended GR (instead the fulfilment of originally $\gamma_a\gamma_b + \gamma_b\gamma_a = 2\eta_{ab}$ according to SRT only). Now the matrices

$$\hat{\gamma}_\mu \equiv e^{a}_{\ \mu}\gamma_a \tag{A13}$$

allow to directly derive a symmetric energy-momentum-stress tensor from an appropriately chosen Lagrangian analogous to that already discussed for spinless particles in [Ostermann 2006, RKQ08]. From the particle-assigned variational principle

$$\delta\int\left(\breve{\mathbf{\Phi}} + \sum\widehat{\mathbf{\Phi}}_{\mathrm{N}}\right)\mathrm{d}\Omega = 0 , \tag{A14}$$

where

$$\breve{\mathbf{\Phi}} := \frac{1}{2\kappa}\mathbf{G} \tag{A15}$$

with $\Gamma_{k,lm}$ the Christoffel symbols of first kind constituting

$$\mathbf{G} \equiv \sqrt{g}\, g^{um} g^{sv} g^{rw} \left[\,\Gamma_{v,ur}\Gamma_{w,ms} - \Gamma_{v,um}\Gamma_{w,sr}\right] \tag{A16}$$

the particle assigned Lagrangian is

$$\begin{aligned}\widehat{\mathbf{\Phi}}_{\mathrm{N}} = {} & \tfrac{1}{4}\mathbf{f}^{kl} f^{\overline{\mathrm{N}}}_{kl} + \\ & e a^{\overline{\mathrm{N}}}_{k}(\overline{\mathbf{\Psi}}\hat{\boldsymbol{\gamma}}^{k}\Psi) + mc^2\overline{\mathbf{\Psi}}\Psi + \tfrac{\mathrm{i}}{2}\hbar c(\overline{\mathbf{\Psi}}_k\hat{\boldsymbol{\gamma}}^{k}\Psi - \overline{\mathbf{\Psi}}\hat{\boldsymbol{\gamma}}^{k}\Psi_k),\end{aligned} \tag{A17}$$

where

$$\hat{\boldsymbol{\gamma}}^k \equiv \sqrt{g}\,\hat{\gamma}^k , \tag{A18}$$

$$a^{\overline{\mathrm{N}}}_{l} \equiv \sum_{\mathrm{n}\neq\mathrm{N}} a^{\mathrm{n}}_{l} , \tag{A19}$$

$$f^{\overline{\mathrm{N}}}_{lm} \equiv \sum_{\mathrm{n}\neq\mathrm{N}} f^{\mathrm{n}}_{lm} . \tag{A20}$$

While an index $\overline{\mathrm{N}}$ means all other particles except for N, the absence of such an index tacitly indicates a particle N (as for example $f_{lm}$ occasionally stands for $f^{\mathrm{N}}_{lm}$ etc.)

A *complete* variation with respect to all electromagnetic potentials $a^{\mathrm{N}}_{k}$, $a^{\overline{\mathrm{N}}}_{k}$, the spinors $\mathbf{\Psi}^{\mathrm{N}}, \overline{\mathbf{\Psi}}^{\mathrm{N}}$, and the tetrads $e^{k}_{\mu}$ yields the fundamental equations of electrodynamics, quantum mechanics, and gravitation as valid in this context. To calculate there the variations of any expression $X$ depending on $g_{ik}$ with respect to the tetrads, these are found conveniently according to the following example

$$\frac{\partial X}{\partial h^{i\lambda}} = \frac{\partial X}{\partial g^{jk}}\cdot\frac{\partial g^{jk}}{\partial h^{i\lambda}} = \frac{\partial X}{\partial g^{jk}}\cdot\left(\delta^{j}_{i} h^{k}_{\ \lambda} + \delta^{k}_{i} h^{j}_{\ \lambda}\right) . \tag{A21}$$

a) The deduction from (A14) of the first pair of *Maxwell equations* for particle assigned electromagnetic fields yields by variation of the corresponding potentials $a^{\mathrm{N}}_{k}$

$$\partial_k f^{kl} \equiv i^{l} = e\,\overline{\mathbf{\Psi}}\hat{\gamma}^{l}\Psi , \tag{A22}$$

where the particle index N is omitted again. Because of the definition of the field strength $f_{lm} = a_{m;l} - a_{l;m}$ the second pair applies as usual

$$f_{ik;l} + f_{kl;i} + f_{li;k} \equiv 0 \ . \tag{A23}$$

b) The deductions by variation of the spinors $\boldsymbol{\Psi}^{\mathrm{N}}, \overline{\boldsymbol{\Psi}}^{\mathrm{N}}$ from the variational principle (A14) of the *Dirac equation* in GRT both yield equivalently

$$\hat{\boldsymbol{\gamma}}^k \left( \mathrm{i}\hbar c \boldsymbol{\Psi}_k - e a_k^{\overline{\mathrm{N}}} \boldsymbol{\Psi} \right) - mc^2 \boldsymbol{\Psi} \ = \ -\tfrac{\mathrm{i}}{2}\hbar c \boldsymbol{\Psi} \partial_k \hat{\boldsymbol{\gamma}}^k \ . \tag{A24}$$

c) The deduction from the variational principle (A14) of *Einstein's gravitational equations* yields

$$\tfrac{1}{\kappa}\mathbf{E}_{ik} \ = \ \mathbf{T}_{ik} \ \equiv \ \sum \mathbf{T}_{ik}^{\mathrm{N}} \ . \tag{A25}$$

In explicit notation, a first quantum EMS tensor density is

$$\mathbf{T}_{ik}^{\mathrm{N}} \ = \ \mathbf{L}_{ik}^{\mathrm{N}} + \mathbf{Q}_{[ik]}^{\mathrm{N}} \ , \tag{A26}$$

where the square brackets in $\mathbf{Q}^{\mathrm{N}}{}_{[ik]}$ mean symmetrization in the indices $i$, $k$, and the summands are

$$\mathbf{L}_{ik}^{\mathrm{N}} \ = \ \tfrac{1}{4} g_{ik} \mathbf{f}_{\mathrm{N}}^{kl} f_{kl}^{\overline{\mathrm{N}}} - \tfrac{1}{2}\left( \mathbf{f}_k^{\mathrm{N}m} f_{im}^{\overline{\mathrm{N}}} + \mathbf{f}_i^{\mathrm{N}m} f_{km}^{\overline{\mathrm{N}}} \right), \tag{A27}$$

$$\mathbf{Q}_{ik}^{\mathrm{N}} = -e_{\mathrm{N}} a_i^{\overline{\mathrm{N}}} (\overline{\boldsymbol{\Psi}}^{\mathrm{N}} \hat{\gamma}_k \boldsymbol{\Psi}^{\mathrm{N}}) - \tfrac{\mathrm{i}}{2}\hbar c (\overline{\boldsymbol{\Psi}}_i^{\mathrm{N}} \hat{\gamma}_k \boldsymbol{\Psi}^{\mathrm{N}} - \overline{\boldsymbol{\Psi}}^{\mathrm{N}} \hat{\gamma}_k \boldsymbol{\Psi}_i^{\mathrm{N}}) \ 28)$$

Thus $\mathbf{T}_{ik}$ is provisionally constituted according to (A25) for the right hand side of Einstein's gravitational equations.

Not only the existence of predictable energy levels in atoms follows from the variational principle (A14) but in particular also Planck's fundamental energy-frequency relation $\Delta\varepsilon = h\nu$ for the first time, both results already demonstrated in "Basic relations of a unified theory of electrodynamics, quantum mechanics, and gravitation" [Ostermann 2008a, RKQ08], where the Klein-Gordon equation has been deduced analogously at first. In brief, there are shown the fundamental features of quantum mechanics (deviating from classical physics), which seemed previously irreconcilable with historical concepts.

In addition it is remarkable that the deductions above prove the Lorentz force to apply between *different* particles only, thus without any electromagnetic self-interaction which otherwise may cause insurmountable problems of renormalization. Furthermore as exemplarily shown there, the results imply Heisenberg's 'uncertainty' relations. These are necessary to describe extended structures as unrealistic point particles. There appears a 'quantum pressure' against attractive forces instead [Ostermann 2006]/7.5.

It is of particular interest that according to the same results the exchange of electromagnetic energy and momentum takes place in form of discrete quanta $\Delta\varepsilon = \hbar\omega$ (photons). Their existence in the electromagnetic fields of respective particles, however, needs further clarification while – on the other hand – it is already obvious there that a the picture of continuous distribution in form of classical electromagnetic waves must fail. Also the historical view is inaccurate, that particles at rest are not localizable if their *total* momentum would equal zero exactly. The need for future development of the whole concept has been exemplarily concluded from the proton in the H atom.

Gravitation regarded as an isolated physical agent alone would be unable to explain in particular how there can be explosions of gravitationally bound objects like SNe, or even the mere existence of stars. Without a covariant inclusion of EMS bi-tensors, the detection of gravitational waves [Abbott et al. 2016] proves GRT to be incomplete, if exclusively focused on pure Riemann tensors.

According to their name the basic *bi*-tensors $e^a{}_i$, which are indispensable to reconcile QM with extended GRT, include two indices of different character. The first one is bound to the quasi-Euclidean universal frame, the second one to the mathematical apparatus of Riemann's non-Euclidean geometry. This again disproves Einstein's historical geometric interpretation, which evidently fails in reducing physics to exclusively Riemannian properties of space and time.

In this context, 'black holes' or a singular origin of the universe if taken literally may be overstrained concepts of conventional GRT, while its strict applicability breaks down near any respective singularity as assumed by Einstein himself (e.g. in the 5th posthumous edition [1973] of "*Grundzüge der Relativitätstheorie*"). According to SUM, quantum mechanics is claimed to set essential limits in retaining matter from vanishing forever. What astronomers really see may be Super-Massive-Objects (SMOs) in equilibrium with quantum pressure instead. In active galactic nuclei (AGNi) or in close vicinity even of quiet SMOs – 'black holes' may be only a synonym for objects of extremest densities – there is not observed an inevitable disappearance of matter and radiation but rather the contrary. Supposed black 'holes' seem paradoxically associated to quasar jets or to most luminous sources of gamma-ray bursts (GRBs) from hypernovae all over the universe.

The new understanding of RT is only a consequent extension of the idea which has led to SUM as the stationary cosmological solution of Einstein's original equations. This idea – no universal horizons, neither spatially nor temporally, must limit physical reality – does not only apply to the meritorious historical concept of 'black holes' but also to the assumption of a non-physical single-bang origin of the entire universe out of nothing. What may safely be stated about 'black holes' is that temporarily non-radiating supermassive objects certainly exist. There might be an analogy to neutron stars (though much more compact), but without any *physical* singularity. The latter assumption, of course, does not exclude provisional mathematical singularities even in a successful unified theory. In temporal near-'black-hole' objects, quantum mechanical processes might occasionally cause giant GRBs (where a corresponding question is whether there could be breaks of rotational symmetry in approximate Kerr metrics).

Accordingly, the extension with respect to universal coordinates of what is called a black 'hole' cannot be zero, but rather equals its Schwarzschild radius $r^*_{\mathrm{BH}} \approx r_{\mathrm{G}}$ due to quantum pressure approximately.

## APPENDIX B: PROOF FOR A PREFERRED COORDINATE SYSTEM BY DETECTION OF GRAVITATIONAL WAVES

The existence of gravitational waves, first proven indirectly from the decreasing period of the binary pulsar PSR 1913+16 [Hulse & Taylor 1975], does mean anything but a confirmation of Einstein's conventional *interpretation* of his general relativity theory.

In accordance with this statement, Tangherlini is right in a topical letter to APS News [Tangherlini 2016]: "… if one wants to stick with the view of gravitational interaction that emerges from Einstein's general relativity, one has to reject gravitons." Consequently it reads: "For Einstein then, gravitational waves are classical waves that one should not attempt to quantize." In view of SUM, however, it is misleading to stick with Einstein's conventional view of space and time as physical agents. Then the logical consequence of Tangherlini's latter statement is unjustified. It would be sufficient to find a quantized EMS tensor of matter $T_{ik}{}^{\text{QM-detailed}}$ fulfilling relation (59) and completed by the corresponding bi-tensor ${}_{(\mathrm{bi})}t_{ik}$ (s. Section 2.3 and Appendix A).

Contrary to a confirmation of Einstein's original interpretation, just the other way round, the detection of gravitational waves [Abbott et al. 2016] proves the existence of a preferred universal frame (even in spite of a possible partial absorption by dark matter in case of some non-detectable frequency ranges). Gravitational waves are undulating distortions of the omnipresent gravitational potentials and energy densities instead of mathematical 'spacetime'. It seems unrealistic to assume them without any absorption.

The preferred universal rest frame is established by the isotropy of any background radiation over sufficiently large scales and the statistically constant values of redshift for individual sources at same distances (s. Section 2.5).

Making use of the Doppler effect, one can always determine a preferred rest frame theoretically ranging as far as ever may be seen. In principle, even without Hubble´s discovery one could have referred to maximal isotropy of cosmological observations as well as to a mean statistical star velocity zero.

Physical reference frames have to be distinguished from infinite fictive coordinate systems thought to be in relative mathematically uniform motion. On the one hand, Einstein has used a special coordinate condition to deduce the equations of gravitational waves, which condition is conventionally understood to be arbitrarily choosable in GRT. On the other hand, the same condition is reasonably used to calculate the measurable densities of gravitational energy and momentum. The latter conclusion, though, is inconsistent because arbitrary coordinate conditions are only allowed if exclusively GR tensors are involved.

It is a fact of fundamental importance that real gravitational fields differ from kinematically equivalent pseudo-fields of acceleration by their non-vanishing Riemann tensor $R_{iklm}$ significantly Here 'accelerated' means with respect to the infinite universal frame (which according to the limitation of 'proper' quantities is only temporarily and locally 'SRT-inertial' again and again).

If in sense of the conventional interpretation prevailing since Einstein, however, it was legitimate to claim any coordinate choice – demanding the fulfilment of four arbitrary relations – then it could apparently be 'proved' that there are no gravitational accelerations at all.

To this end one might choose as the simplest of all conceivable coordinate conditions

$$\mathbf{T}^{kl}\partial_i g_{kl} = 0, \tag{B1}$$

what means

$$\partial_k \mathbf{t}_i^k = 0, \tag{B2}$$

and thus

$$\partial_k \mathbf{T}_i^k = 0. \tag{B3}$$

According to Einstein's provisional replacement of $\mathbf{T}_i{}^k$ by his phenomenological kinetic energy-momentum tensor

$$\mathbf{T}_i^k := \mathbf{K}_i^k \equiv \mu c^2 U_i U^k \tag{B4}$$

in analogy to (6), however, there would follow

$$U^k U^l \partial_i g_{kl} = 0 \quad \Leftrightarrow \quad \frac{\mathrm{d}U_i}{\mathrm{d}s} = 0\,. \tag{B5}$$

Thus each object would move uniformly straight-line with respect to the chosen coordinate system, apparently without gravitational acceleration there.

In this case, here is actually no exchange between the EMS tensor of matter $T_i{}^k$ and the so-called pseudo tensor $t_i{}^k$ of the field. Correspondingly an emission of gravitational waves – at least in form of Einstein's historic approximation (including the chance for gravitons) – would be impossible. Therefore regarding the unsuitable coordinate condition (B1) the valid conclusion is, since *not any* arbitrarily chosen coordinate system does represent a physical acceptable reference frame, there must exist a preferred one. The only thinkable alternative out of this dilemma could be to find a new GRT-tensor $\hat{t}^{ik}$ (possibly built from the components of $R^i{}_{klm}$ with help of tetrads) as an equivalent for the conventional $t^{ik}$. Instead of relation (B2), a more appropriate coordinate choice might allow to require

$$\partial_k\left(\mathbf{t}^{ik} - \mathbf{t}^{ki}\right) = 0 \tag{B6}$$

providing an effective symmetrization of the interaction between matter and the gravitational field, which is otherwise missing in Einstein's original expression for $t^{ik}$.

Only with regard to the *preferred frame* fixed by the universal potential, however, there is a true energy density of the gravitational field independent of the respective *coordinate system*. Even the hDM radiation equilibrium stated in Section 5.3 might be realized via mutual exchange of gravitational energy.

Therefore it is suggesting to make use of the natural existence of the preferred universal rest frame as determined by the isotropic distribution of redshift on ultra-large scales ($z \gtrsim 0.1$) or by the CMB, if presupposed here to be consistent. As is well known, the 'absolute' velocities of earth and sun have been measured on this basis.

Even if our cosmos turned out to be part of a 'multiverse' consisting of similar structures, a preferred frame should always be found. A serious problem might only arise if there was more than one such frame one day (s. the question of a 'dark flow' [Kashlinsky, Atrio-Barandela, & Ebeling 2012]), what would force to go to larger scales.

Summarizing it may be stated that probably the most important arguments of all for such a preferred frame are found in Einstein's relativity theory itself.

α) Only with regard to the universal rest frame it is possible to define gravitational potentials in that way, that they fulfil linear wave equations approximately.

β) Only with regard to the universal rest frame it is possible to take naturally account for the localizability of energy and momentum of the gravitational field. In contrast to Einstein's conventional interpretation, this can be achieved by Rosen's bi-metric reformulation of general relativity theory (s. Appendix A).

γ) Only with regard to the universal rest frame it is possible to keep the conservation law of angular momentum valid even over ultra-large scales.

δ) Only with regard to the universal rest frame it is possible to exclude any arbitrarily chosen smooth coordinate conditions except for applications in mere 'timetables' of stellar motions (the latter without relevant statements about energy-momentum *densities*). Otherwise – as seen above – one may ask: Why should such coordinate conditions not be allowed to transform all gravitational accelerations away?

Today, only an alternative interpretation of an extended relativity theory according to updated concepts of Lorentz and Poincaré is able to take convincingly account for the aspects α) – δ) with help of Rosen's reformulation of GRT. This chance has become realistic after his 'bi-metric relativity' is uniquely fixed to the preferred universal frame now.

Though obviously 'freely choosable' coordinate conditions exist, these are inappropriate to describe any exchange of energy-momentum densities by gravitational waves. Since relation $\mathbf{T}_{i;k}^{k} \equiv 0$ is independent of any coordinate choice identically fulfilled, even in the case discussed above ($\partial_k \mathbf{T}_i^{k} = 0$) this should yield a spatial converge of the pulsar PSR 1913+16 to its companion together with its decreasing periods actually observed. It cannot yet be safely excluded that from the perspective of co-rotating observers a calculation, using a synchronously shrinking rotating coordinate system, could also work in this special case. Even then, however, there would remain the question which preferred coordinate condition can be applied in *all* situations.

According to Einstein, in general such an attempt would fail. When Felix Klein once mentioned Carl Runge's proposal of (B2) in a letter as 'the egg of Columbus', Einstein replied that this condition cannot account for the energy loss by emission of gravitational waves (s. Doc.s 487,492 of CPAE vol. 8B). In 1918, two months later, Einstein succeeded in providing an important step to clarification in *"The energy conservation law in the general theory of relativity"* [Einstein 1918], though he still did not draw the ultimate consequence.

Considering the conservation law $\partial_k(T^{ik} + t^{ik}) \equiv 0$ (equivalent to $\mathbf{T}_{i;k}^{k} \equiv 0$) he argued that the barycentre of a closed system must be at rest or in uniform motion with respect to the 'fixed stars'. Obviously he presupposed the actual existence of a corresponding preferred universal frame. And while he continues claiming the 'rest-energy' of a closed system to be independent of the coordinate choice, this statement applies only under the explicit presupposition of local coordinates embedded into 'one and the same' Galilean system at infinity (mathematically equivalent to Newton's concept of 'absolute' space and time). The other way round this means that in general without 'one and the same' preferred universal frame, energy and momentum of closed systems would *not* be conserved.

Einstein's first implicit admission, however, that sensible coordinate conditions have to be compatible to those leading approximately to linear equations for gravitational waves questions the necessity of his purely geometrical concept of curved space and time as physical objects. Historically, only the assumed absence of a universal rest frame has been the reason for Weyl [1922] to keep adhering to the literally geometric interpretation, thus in contrast to Poincaré's mathematically equivalent concept (accepted as a legitimate alternative 1921 in *'Geometrie und Erfahrung'* by Einstein himself).

Regarding the existence of gravitational waves, the term 'universal rest frame' used above rather means only a category of fictive 'SRT-inertial' systems in uniform relative motion at first. But then, taking a telescope-look to redshifts and the microwave background in the sky enables to identify the unique preferred frame.

Now the first direct detection of gravitational waves has shown that the previously assumed coordinate-dependent 'pseudo'-tensor $t^{ik}$ of GRT actually has to be understood a real bi-tensor ${}_{(\mathrm{bi})}t^{ik}$. On the one hand, this then provides the localizability of gravitational energy density. On the other hand, a consistent GRT concept of gravitational potential energy has not yet been achieved thus far. In particular, it is not at all clear, how any differences in a *negative* local Newtonian potential energy of e.g. a binary system can be converted in detail to gravitons of *positive* energy at last, which according to quantum mechanics should be a materialization of the gravitational waves just observed.

Because of missing integrability, local proper time together with local proper length – both effectively displayed by atomic clocks – are inappropriate to describe non-static processes completely. This statement applies even in simple stationary systems like a rotating disk for example. All the more, the limited SRT concepts are inappropriate to describe consistently all processes over large scales within a stationary universe. In contrast, a complete physical description of reality can be only achieved (if at all) using mathematical system coordinates as Einstein recognized after Kaluza's treatment of Ehrenfest's paradox. Outside fictive infinite inertial systems, however, such coordinates cannot be realized using atomic units continuously over universal periods or distances.

According to both postulates used to deduce the stationary line element (Section 2.1), it is possible in principle to fix universal coordinates uniquely. The following definition is obviously consistent:

– The *universal* coordinates ($t^*$, $x^{*\alpha}$) are understood to be those of an Euclidean space filled with a stationary, homogeneous and isotropic ultra-large scale distribution of matter and energy, where the universal coordinate speed of light $c^* = c$ is constant. Evidently, these coordinates (where $t^* = 0$ means any arbitrarily choosable reference point of universal time) represent the natural *preferred frame* of the universe, which suggests itself to be statistically identified with the rest frame of the CMB or the isotropic distribution of redshifts (both references have to coincide in a consistent model):

– In contrast to the universal coordinates ($t^*$, $l^{*\alpha}$), their temporary *local* approximations are ($dt_{\mathrm{SRT}}$, $dl_{\mathrm{SRT}}$). These intervals, named 'proper time' and 'proper length', are measurable directly using atomic clocks and spectral rods within sufficiently small regions which are local with respect to space *and* time. Contrary to current understanding, however, the approximations of proper time and length are realized necessarily *together*, according to the line element (27) of special relativity theory (SRT) within local inertial frames.

Thus the term 'proper time', though commonly used, seems problematic or even misleading insofar it is just possible as well, to take the assumption that there is only one *universal time*. In this view 'proper time' has to be understood as the *display* of atomic clocks affected by gravitational potential and universal motion. The same consideration applies also to the commonly used term 'proper length', which turns out to be problematic or even misleading insofar it is just possible as well, to take the assumption that there is only one *universal length*. In this view 'proper length' has to be understood as the *displayed number* of spectral unit sticks, affected by gravitational potential and universal motion, again.

In the context of this section it is a strange marginal aspect that the successful observation of the well-known velocity dipole might be found another kind of Michelson's first attempt to measure terrestrial motion against a preferred universal frame (actual of a mysterious 'ether' assumed at those times instead of the CMB today).

According to SUM the preferred universal coordinates provide an explicit fixation of Rosen's bi-metric relativity. Only in this form there will be a chance to include also gravitons into the ensemble of particle physics if necessary.

## APPENDIX C: A BRIEF HISTORICAL REVIEW

There are several aspects showing the stationary universe model as a natural step in the development of relativistic cosmology.

Looking for a model of an eternal infinite universe, after going beyond the first beginnings of relativistic cosmology by Einstein [1917], de Sitter [1917], Friedman(n) [1922/24], it has been thought for more than half a century that the only reasonable alternative to a 'big bang' solution as essentially suggested by Lemaître [1927/31] would be the 'Steady-state Theory' (SST) developed by Bondi & Gold [1948] and Hoyle[1948/49]. It is well-known, however, that in spite of its reasonable objective the SST has proved obsolete. This failure unfortunately applies to its expanding-space concept as well as to its relativistic line element different from (1), (3) [SUM14/A1].

But it is hard to believe, on the one hand, that Einstein's equations should definitely fail to describe a stationary background while, on the other hand, it is widely assumed today that something like quantum fluctuations existed before according to the CCM a 'big bang' had taken place. A 'false vacuum', however, would have been anything but empty space, thus requiring its own line element in the framework of Einstein's gravitational equations.

It has been shown in this paper that, above all for observational reasons, instead of the SST the new stationary-universe model (SUM) – essentially different, though of related intention – proves an actual alternative to today's standard cosmology.

No need to emphasize the feature at large that the CCM as developed in recent years is representing most relevant numerical facts exceptionally well. Furthermore, the underlying concept of a hot 'big bang' singularity, followed by an assumed phase of 'inflation' leading to a ΛCDM universe, has inspired the overwhelming cosmological discoveries of the last decades.

### C.1 Einstein's overlooked rediscovery of Newton's mathematical space and time

Do spectral unit sticks together with atomic clocks necessarily display valid physical space and valid physical time, if they – side by side at rest next to each other and sharing the same physical conditions – always and everywhere would show the same intervals? No. This condition also applies to real clocks and real unit sticks since all of them are respectively affected to the same extent.

Einstein himself found proper length and proper time insufficient to describe processes on a rotating disk and thus insufficient to cover consistently the complete complex of physical experience.

If the term 'physical' can be taken as a synonym for 'meeting all physical requirements', then it was Einstein who found:

> *" ... Just as little it is possible to introduce a time meeting all physical requirements in K', which is displayed by identical clocks relative to K' at rest."* – [Einstein 1916], p. 775, transl. by author (K' means a coordinate system fixed to a uniformly rotating frame).

On the same page, a few lines below, he continues summarizing this problem:

> *"... In general relativity theory it is impossible to define quantities of space and time in such a way that spatial coordinate differences could be measured directly using a unity stick, or temporal ones using a standard clock."* – [Einstein 1916], p. 775 (transl. by author)

Here obviously "unity stick" and "standard clock" mean proper length and proper time. The other way round, the "time meeting the physical requirements" is what later has been called 'coordinate' time in the GRT framework.

It was the necessity finally concluded from Ehrenfest's fundamental paradox [Ehrenfest 1909] of the rotating disk – subsequently to Kaluza's pioneering mathematical treatment [Kaluza 1910] (s. also [Stachel 1989], [Ostermann 2002]) – which led Einstein to introduce into relativity theory a system time $t^*$ different from proper time $t_{\mathrm{SRT}}$ as displayed by natural 'proper' clocks, and system coordinates $x^{*\alpha}$, which in their entirety cannot be reduced to 'proper' lengths $(l_{\mathrm{SRT}})^{\alpha}$ as displayed by material measuring rods. From this historic distinction it is obvious that today, for the sake of clarity, the fundamental SRT attribute 'proper' may be always replaced by the synonyms 'atomic' or 'spectral'.

Thus with Einstein's system coordinates of GRT, only ten years after his formulation of special relativity theory [Einstein 1905], unpretentious representatives of 'absolute' space and 'absolute' time had actually come back to physics, though as mere 'mathematical' quantities after all.

On the one hand, *special* relativity theory shows that despite length contraction and time dilation it is possible to choose coordinates within inertial frames, whose differences correspond to directly measurable intervals of 'proper' length and 'proper' time. On the other hand, however, what is called *general* relativity theory soon showed that this is impossible for extended non-inertial frames. Then with help of his ingenious equivalence principle Einstein transferred that impossibility to real gravitational fields where the Riemann tensor is different from zero ($R^{i}_{\ klm} \neq 0$, in contrast to mere 'acceleration fields' whose corresponding tensor always would vanish completely).

Thus, given the natural fact that only *local* inertial frames do exist, this requires the existence of mathematical space and mathematical time – effectively corresponding to Newton's concepts – to describe physical reality all over the universe.

In view of the conclusions drawn here about the meaning of 'system coordinates', all statements on 'spacetime' of relativity theory may most simply be interpreted exclusively as statements on real objects, fields, rods and clocks, which are subject to *gravitational potential* and *motion* in universal Euclidean space and universal mathematical time [Ostermann 2002]. In contrast to what is conventionally called 'relativistic spacetime', it is simply unnecessary to ascribe any physical qualities or quantities to universal space and universal time themselves [Einstein 1920]. They may be understood to be no physical agents at all (s. Appendix C.3.2).

Objects of physical description are only the changes compared to what is unchangeable by mathematical presupposition, and whose unchangeability does not require any explanation (it may be explicitly reminded here to the fact that it is impossible to do any science without axioms, which – though of claimed literally 'evidence' – are always unprovable presuppositions at last).

Therefore, what is the universal time? If any coordinate time may represent the internal time of a corresponding subsystem, then the mathematical coordinate time of the universe $t^*$ has to be regarded the *universal* time. Accordingly, with respect to sufficiently large scales of universal Euclidean space – where homogeneously and isotropically distributed astrophysical objects, in particular clusters of galaxies, are statistically at rest – the universal time is determined (without one naturally fixed zero point, of course) by the condition of a constant universal coordinate speed of light $c^* = c$ (despite of small deviations due to local inhomogeneities).

Regarding the above expression 'coordinate speed of light', in the context of GR apparently most authors try to avoid the simple term 'speed of light' except with respect to inertial frames (s. e.g. the subject indices in the textbooks of Weinberg [1972], Misner, Thorne, & Wheeler [1970], Will [1993] and others). Nevertheless, in Weinberg's work (p. 222) it reads: "*... the photon speed is given by the condition* $0 = -g_{\mu\nu}(dx^{\mu}/dt)(dx^{\nu}/dt)$". And Shapiro who has been the first one to measure a solar radar echo delay (the only classical test characteristically 'forgotten' by Einstein) wrote in his first paper [Shapiro et al. 1968] on this issue *"... the speed of a light wave depends on the strength of the gravitational potential along its path ..."*. Both quotations are dealing with the non-constant 'coordinate speed of light'. Therefore this might in general be named 'speed of light' $c^*$ in contrast to the designation 'constant speed of light' $c$ within local inertial frames (there $c$ is the fundamental natural constant).

Initially, of course, Einstein was perfectly aware of the general non-constancy since he had discovered his equivalence principle in 1907 with necessarily bended light rays in his fictive accelerated elevators. But thereafter he seemed temporarily confused with SRT on Ehrenfest's rigidly rotating disk [Ostermann 2002], s. also "A natural vierbein approach to Einstein's non-Euclidean line element in view of Ehrenfest's paradox" in [SUM14/A2].

The impossibility to identify spatial universal system coordinates unambiguously within local subsystems alone, however, cannot disprove their existence, just as in case of temperature dependent unit sticks the necessary reference to non-Euclidean geometry when using arbitrarily chosen curvilinear coordinates could not disprove the flatness of a perfect plane.

In the SUM framework even the *physical* existence of universal space is obvious from the fact that according to (37) the universal distance $l^*$ of a galaxy at rest is directly measurable by its redshift. This conclusion is further supported by Newton's bucket argument, particularly since his 'absolute' mathematical space now seems established, on the one hand, by statistical ultra-large scale isotropy of redshift and background radiation (Appendix B) as well as, on the other hand, by the indispensable bi-metric tetrads.

From the above it seems plausible, that what Einstein called "meeting all physical requirements" implicitly means Newton's concepts, which in the conventional GRT framework are called 'coordinate' length and 'coordinate' time. Accordingly the universal time $t^*$ in the stationary line element (4) is 'absolute' in that it is passing uniformly forever without relation to any natural events.

*"Absolute, true, and mathematical time, of itself, and from its own nature, flows equably without relation to anything external [ ... ] Absolute space, in his own nature, without relation to anything external, remains always similar and immovable ..."* – (from the *Scholium* in the English edition of Newton's *Philosophiae Naturalis Principia Mathematica*). While because of the new context this is not completely the same as GRT's system coordinates, unfortunately Einstein's effective rediscovery of Newton's mathematical space and time had apparently fallen into oblivion before De Sitter, Friedman(n) and in particular Lemaître started to develop modern relativistic cosmology.

Though Einstein's equations are mathematically clear, their interpretation may be subject to further discussion. Everyone seems free to adhere to the historical view of SRT with no preferred inertial system of the universe. But such an unnecessary concept of literal relativity would only apply to processes within fictive infinite inertial systems. Two particularly simple reasons weaken Einstein's SRT interpretation substantially today.

At first, due to the gravitational background field no universal frame can be a assumed to be a pure 'SRT-inertial' one. The reason is that, in contrast to freely falling local approximations, a real universal inertial frame with objects in steadily uniform motion of constant velocities simply cannot exist. Otherwise the Riemann tensor $R^i{}_{klm}$ of the universe would vanish and – according to Einstein's original equations – the world would be empty of matter and energy.

At second, even if understood as a mathematical idealization, nobody is prevented to take a 'look out the window'. Telescopes would show statistical isotropy with respect to one preferred universal frame, and apparently they do.

## C.2 The CCM conclusion from the SNe-Ia data of an alleged universal acceleration

In case of today's CCM it is nearly impossible to work out high precision cosmology without fundamental priors including essentially unknown physics. The exact CMB and its anisotropies, for example, are only determined after subtraction of some 'unsuitable' microwave radiation as a small part of the CIB [Kashlinsky 2005], [Ade et al. 2011]. Therefore it seems appropriate to recall briefly some ΛCDM essentials for comparison.

The CCM is governed by a spatially flat line element of FLRW form, with a matter density $\rho_\mathrm{M} \approx 0.3\rho_\mathrm{c}$ inclusive of 'dark matter', and an amount of 'dark energy' $\Lambda/(8\pi G/c^4) \equiv \varepsilon_\Lambda = (\rho_0 - \rho_\mathrm{M})c^2 \approx 0.7\rho_\mathrm{c}$ due to a cosmological constant $\Lambda$ (first exact values concluded from WMAP [Bennett et al. 2003], [Jarosik et al. 2011]). Here it is $\rho_0 \equiv \rho_\mathrm{total} \approx \rho_\mathrm{c}$ with $\rho_\mathrm{c} \equiv 3H_0^2/(8\pi \mathrm{G})$ the critical density, $G$ Newton's gravitational constant, and $H_0$ the conventional Hubble parameter $H_\mathrm{c}(t'=0)$ today. The present 'deceleration' parameter is $q_0$, and $T'_0$ is called 'age of the universe'.

Several well-known pillars are supporting the CCM. Besides the 'predictions' concerning the magnitude-redshift relation of SNe-Ia or the primordial nucleosynthesis (s. however the lithium problem [Fields 2011]), of all pillars the CMB black-body radiation together with the almost perfect description of its anisotropies are the strongest arguments for a hot 'big bang' in the ΛCDM framework, see e.g. Durrer [2008] (where fundamental unproven hypotheses underlying the CCM and its mathematical treatment are also explicitly addressed).

In particular the paradigm of inflation however – indispensable for that model – is raising serious doubts [Steinhardt 2011]. There is neither a clear theory of such a scenario nor any detection of a corresponding scalar inflaton field which is needed to solve the problems of universal horizons or approximate flatness. Also the fundamental baryon asymmetry (matter-antimatter) has to be mentioned in this context, not to forget several other questions concerning the initial singularity and fine tuning, for example.

It is clear from the beginning that in any 'big-bang' cosmology there will remain purely coincidental aspects. These seem particularly difficult to accept as long as they concern the universe as a whole. Therefore it is a natural question whether instead of inflation there might be an alternative to reconcile relativistic CCM cosmology with those observational facts which otherwise mean a fundamental dilemma each.

Figure 10 shows a first naive SUM confrontation (red) with the SNe-Ia data (diamonds or circles) against the CCM 'prediction' (blue), which claims this diagram to prove an accelerated expansion of the universe.

Since the bold blue CCM-line in the upper panel (a) of Figure 10 is best fitting the SNe-Ia data, one has to consider the residuals. If temporarily using the same Hubble constant $H_0 = 65$ km/s/Mpc for both models, this would show a global deviation from the red broken horizontal SUM-line

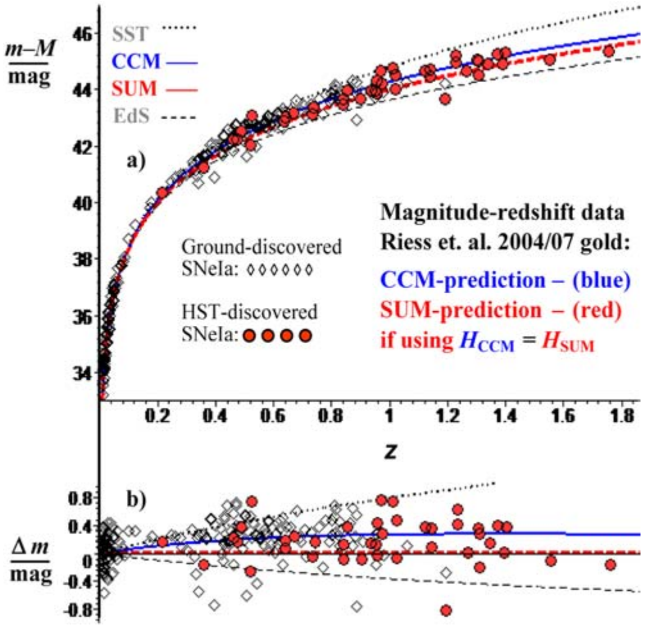

FIGURE 10. – *Top panel (a):* The SNe-Ia data taken from Riess et al. [2004, 2007] are compared to the distance moduli *m–M* of various models. Temporarily using the same parameter $H_{(0)}$ for all models at first, the SUM magnitude-redshift prediction is naively compared (red broken line) to the CCM-prediction (blue line) which stands for the best fit representing a flat space model with $\Omega_\Lambda = 0.73$. In addition to the CCM there are also shown its 'parents' SST, EdS (grey broken lines above and beneath). The red, blue and grey lines represent the predictions derived from the scale factors $a_{SUM}$, $a_{CCM}$, $a_{SST}$, and $a_{EdS}$ as given in Section 3. According to the quoted High-z Supernova Search Team papers, the ground-discovered SNe Ia of their 'gold' sample are plotted as black diamonds whereas the HST discovered SNe Ia are represented by red filled circles. *Bottom panel (b):* The magnitude-redshift residuals and the CCM prediction are shown both with respect to the first provisional SUM prediction (naively assumed the CCM value of the Hubble constant $H_0$, neglecting any local peculiarities or dimming by grey dust). Since the blue CCM-line is best fitting the data and their Δ*m*-residuals, it is seemingly resulting an unacceptable deviation from the red horizontal SUM-line here. This may be why such a model has not been taken seriously so far.

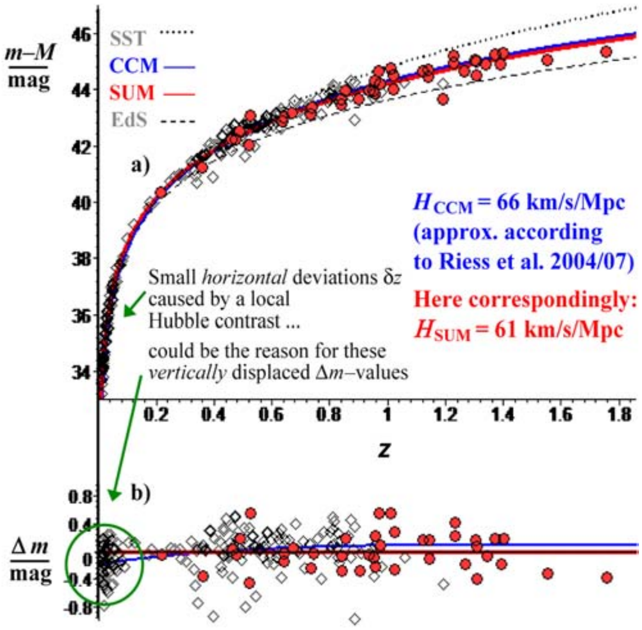

FIGURE 11. – *Top panel (a)*: A vertical shift of $\Delta m \approx 0.2$ mag is sufficient to remove all visible differences between the red SUM-line and the blue CCM-line here. This example means nothing but a reduction of about 8.3% in the Hubble constant (if e.g. $H_{CCM}$ = 71 km/s/Mpc then $H_{SUM}$ = 65 km/s/Mpc). But now there are hidden differences which come to light by plotting the new residuals. – *Bottom panel (b)*: Though this panel still shows significant deviations between the CCM- and the SUM-residuals, the picture has changed essentially, because now the remaining problem is only a local one concerning the low redshift-range $z \leq 0.10$, whereas CCM and SUM both describe the observed universal SNe-Ia-range 0.10 < *z* < 1.8 comparably well (the SUM fits even slightly better than the CCM here). – Both panels illustrate the SNe-Ia measurements still without taking into account any Hubble contrast or dimming by grey dust.

in Figure 10(b). There the Δ*m*-residuals of the SNe-Ia data themselves as well as those of the CCM, SST, and EdS are displayed relative to the SUM prediction. Thus a preliminary assumption of the same Hubble constant over the full redshift range seems to prove an inappropriate SUM-approach at first glance.

Nevertheless the red broken lines in both panels of Figure 10 show, that even straight off this naive SUM-prediction would be much less incompatible to the data than those of EdS or SST (upper and lower broken grey lines), though there are also not yet considered any possible effects of our peculiar cosmic environment or of an acceptable weak dimming by 'grey dust'. That by the SNe-Ia measurements not only the old SST but also the EdS cosmology are disproved, is commonly understood a safe conclusion.

Today, the CCM represents a combination of both, while the seeming local SUM disagreement in Figure 10(b) is most likely the reason why this model – developed only several years later – has not been taken seriously so far. Nevertheless, the upper panel (a) of the same Figure 10 strongly suggests the small vertical shift to the blue CCM-line as applied in Figure 11.

In fact, still neglecting all other 'local' cosmic peculiarities, but based on two different Hubble constants $H_{\text{SUM-provisional}}$ = 61 km/s/ Mpc in contrast to $H_{CCM}$ = 66 km/s/Mpc, the top panel (a) of Figure 11 shows the interim SUM prediction surprisingly close to that of the CCM now. Though looking different, this figure is physically equivalent to Figure 10(a), since the absolute value of $H_0$ is arbitrary here. According to the new assignment of the *universal* Hubble constant, however, the SUM lines of Figure 11 are vertically shifted by $\Delta m$ = 0.2 mag, what according to (46) [without absorption, i.e. $\kappa = 0$] means a reduction in the range $z > 0.1$ of the preliminarily adopted CCM Hubble constant by about 5 - 6 km/s/Mpc. More realistic values are given in Section 3.2. while only the relative difference $\Delta H/H \approx 9\,\%$ is relevant for such an adjustment.

Obviously this small vertical shift has been sufficient, to remove all visible differences between the blue (CCM) and the red (SUM) solid lines in Figure 11. In its upper panel (a) the predictions of both models seem to coincide almost completely now. Despite of the $\Delta m$-shift, however, there remain some *hidden* differences which come to light by plotting the residuals with respect to the $H_{\text{SUM-provisional}}$ prediction. Only when analysed in detail, a relevant difference appears primarily within the green circle of the lower panel (b) of Figure 11.

Though this plot still shows significant deviations between the CCM- and the SUM-residuals, now the remaining problem is only a *local* one concerning the low redshift-range $z \leq 0.1$, while CCM and SUM both describe the observed *universal* SNe-Ia-range $0.1 < z < 2$ comparably well (the SUM fits slightly better than the CCM there). This strongly suggests the local Hubble contrast as discussed in Section 3.2.

Since early CCM parameters $\Omega_{\text{M}} = 0.263$, $\Omega_{\Lambda} = 0.737$ have been shown to coincidence approximately with SUM's 'boundaries' (Section 3), its FLRW-form (50) is suggesting an attempt to get the CCM cosmos with local evolution fitted therein. Free parameters might describe our peculiar environment. Thus it seems a natural question whether an open SUM could be an alternative including pre-inflation as well as post-inflation scenarios, too.

In this view, what would all those important CCM achievements mean, explaining the cosmic evolution of matter, radiation and other more exotic components of the universe? In any case, most – if not all – of the problems concerning today's standard model of cosmology appear in a different light. This because strange peculiar features, if unacceptable for the universe as a whole, might need no justifications, if understood as those of our 'local' cosmos only. Therefore from the perspective of the simplest conceivable model based on Einstein's equations, a suggestive attempt could be to adopt today's cosmology embedded into an open SUM, the latter describing the natural background where 'local bangs' would take place.

## C.3 Overcoming early aspects of relativistic cosmology

How could the clear stationarity of the SUM line element (4) happen to escape its discovery in those times, when the SST attempt has been developed and then was widely discussed? Four main reasons may be:

i) The coordinate time $t'$ of the FLRW form has been misunderstood as a universal proper time whereas according to SUM this concept – and any other SRT concept, too – can apply only 'locally', as stated in Sections 2.4, 2.7.

ii) A negative gravitational 'dark' pressure $p^*$ of one third the critical energy density has not been considered a physical option. Such a chance could be accepted only later after the breakthrough of the SNe-Ia observations. Now it is shown to be an important plausible feature in the SUM framework (s. Section 2.3). In view of Kolb's [1989] 'coasting cosmology' – mathematically, but scarcely physically related – this negative pressure was interpreted as a property of a 'K-matter' instead.

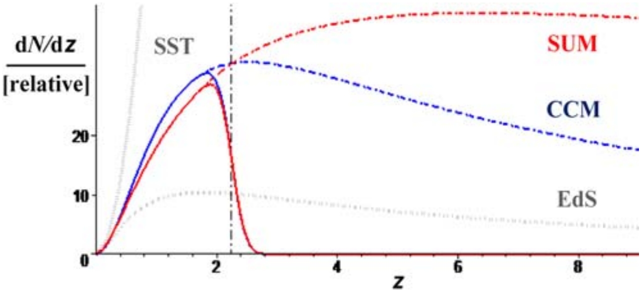

FIGURE 12. – Theoretical distributions dN/dz of universal objects (relative numbers) assuming a homogeneous number density and neglecting effects of absorption or evolution. With regard to both solid lines, a smoothed Malmquist cut-factor is taken into account according to a magnitude limit of about 20.2 mag (corresponding to the vertical black broken line) as used in the SDSS Data Release 7 [Schneider et al. 2010] for example. It are shown the red SUM lines according to (58) together with the blue lines of the CCM-prediction (C1) given $H_{\text{CCM}}$ and $H_{\text{SUM}}$ according to Section 3.2 and the best-fit CCM parameter $\Omega_{\Lambda} = 0.73$ as used there. The cut-factor above is $\frac{1}{2}\{1-\Phi[4(z-z_{\text{limit}})]\}$ with $\Phi$ the Gaussian integral-function. For illustration are shown corresponding SST- and the EdS-predictions derived in [Ostermann 2003, RKQ08] as grey dotted lines.

iii) The stationarity of SUM's unchanging values of redshift have been concealed by the misleading conventional Hubble parameter which is $H_{\text{c-SUM}}(T') \equiv (\mathrm{d}a_{\text{SUM}}/\mathrm{d}T')/a_{\text{SUM}} = 1/T'$ in case of SUM. Unfortunately this conventional parameter has been indicating a dependence on time where actually no such dependence exists. Instead, the significant Hubble constant is $H_{\text{s-SUM}} \equiv H\ (= \mathrm{d}a_{\text{SUM}}/\mathrm{d}T')$, as shown in Section 2.7. This conclusion has been found evident from the unquestionable presupposition that the universal sources of stellar radiation are statistically at rest with respect to the 'comoving' (universal ) distances $l^*$, but definitely not with respect to corresponding 'proper' distances $l'$. Therefore it is a wide spread mistake to assume the conventional Hubble parameter $H_{\text{c}}$ to be the basic observable of redshift. Though in case of SST this conventional Hubble parameter would be misleadingly a constant, for example, that model's individual redshifts were not.

iv) The distribution of quasars seemed to indicate that, on the one hand, these objects did only exist at ultra-large universal distances outside our cosmic environment; but in the meantime the latter's dimensions are seen much wider. On the other hand, there has been assumed a peak seemingly incompatible with a stationary universe. Taking into account a possible Malmquist bias, however, such an apparent maximum in the quasar distribution at about $z_{\text{obs}} \approx 1.9$ is not yet unambiguously observed.

From a lack of clear observation suffer several more fundamental CCM features, too, here only to mention the assumed 're-combination' (following the miraculous 'big bang') but then compensated after a 'dark phase' by 're-ionization' (necessary to reflect today's reality). Other

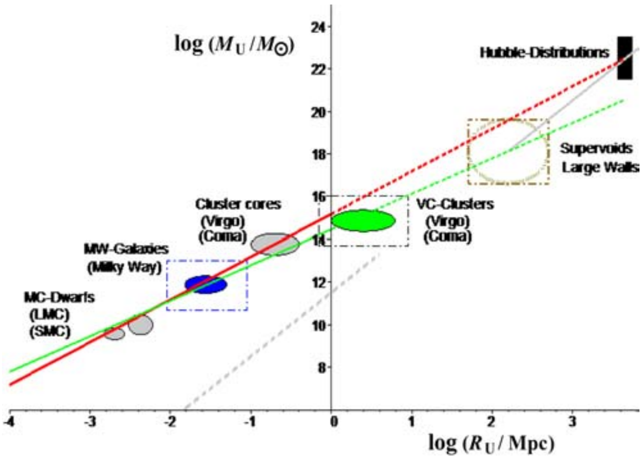

FIGURE 13. – Diagram of a tentative SUM mass-to-radius relation for gravitationally bound objects as discussed in [SUM14]. The radii $R_U$ as and the masses $M_U$ of universal objects, however, are not well-defined. In particular, the respective radii of galaxies and clusters may roughly correspond in orders of magnitude to values between effective core radii of their dark-matter distribution and observable sizes. Also the masses of those structures are approximately known with huge uncertainties. Obviously this preliminary figure does mean no claim, but a question.

strange CCM features may find reasonable explanations in the SUM framework taking various selection biases into account as well as possible effects of local cosmic evolution together with frequency-dependent attenuation of light (extinction, absorption, scattering, or obscuring).

Unexpected giant Lyman-α blobs – with a content of hydrogen gas apparently sufficient to build new stars or galaxies even today – are among the largest known individual objects in the universe. That selection effects can suggest an erroneous impression of particularly large distances is exemplarily shown by these objects, which preferentially are found at high redshifts $z > 2$ because the original UV photons have to be redshifted before they can propagate through the atmosphere.

Still assuming the idealized uniform number density $n_U{}^*$ presupposed in Section 2.8, here may be compared different large scale distributions of universal objects as predicted by the SST, the SUM, and the EdS model, what means pressure-parameters $w = p^*/\varepsilon_c$ of –1, –1/3, 0, or in case of the CCM $w_M \approx 0$, $w_\Lambda \approx -1$. These pressures correspond respectively to a cosmological constant, the stationary gravitational pressure, pressure-free matter, or to two parameters of what in the CCM is called a 'strange recipe'.

It is well-known, that the observed quasar distribution – as reported in the SDSS Data Release 7 by [Schneider et al. 2010] – shows a steep decrease to almost zero within the interval of about 2 < z < 4, whose counterpart is not seen in relation (58). Therefore a comparison of this observed feature with the corresponding distributions of SUM and the CCM – though in both cases neglecting quasar-specific evolutionary effects – may be roughly illustrated here.

Analogously to the SUM prediction, a comparable quasi-CCM prediction d$N$/d$z$ can be derived from (56) where $r^*$, d$r^*$ have to be correspondingly replaced by $l'$, d$l'$ according to (30), (55), what yields

$$\frac{\mathrm{d}N_{\mathrm{CCM}}}{\mathrm{d}z} = 4\pi n^* R_H^3 \cdot X\,, \tag{C1}$$

with $X$ temporarily

$$X = \frac{\left(\displaystyle\int_0^z \frac{\mathrm{d}z'}{\sqrt{\Omega_\mathrm{M}(1+z')^3+\Omega_\mathrm{R}(1+z')^4+\Omega_\Lambda}}\right)^2}{\sqrt{\Omega_\mathrm{M}(1+z)^3+\Omega_\mathrm{R}(1+z)^4+\Omega_\Lambda}}\,, \tag{C2}$$

(s. [SUM14] where also a tentative mass-to-radius relation, Figure 13, is shown for gravitationally bound objects).

Now, as can be seen from Figure 12, taking into account the magnitude limit of about 20.2 mag as used in the SDSS Data Release 7 quoted above, a corresponding smoothed Malmquist cut-factor – due to statistical scatter of absolute magnitudes, for example – may change both distributions from the broken lines to the solid red and blue line, which show a similar steep decrease to about $z \approx 2.3$ now. On the other side, it cannot be firmly excluded that the reason why quasars seem to occur only at redshifts z > 0.05 might partially find an explanation in its low number density together with a corresponding gravitational offset or also in our coincidental local situation. The median redshift of z ≈ 1.5 observed in Data Release 7 seems compatible to both the SUM or the CCM solid lines in Figure 12.

Once accepted a negative gravitational pressure together with some properties of 'dark' matter (hidden for a long time), there seem to remain only historical reasons that the unexpected features of the new model SUM have been ignored so far.

### *C.3.1 The law of entropy restricted to evolutionary processes*

It is evident that in a stationary universe the law of entropy has to be restricted to evolutionary processes outside possible 'local bangs'. The distinction again between local evolutionary cosmoses and the stationary infinite universe also allows a solution in principle of several associated classic problems as named 'Loschmidt's paradox', 'Poincaré's recurrence theorem', or 'heat-death of the universe'.

Provisional statement*:* The natural increase of entropy takes place in evolutionary processes only.

The other way round, a violation of the second law of thermodynamics would be irrefutably restricted to local regions beyond evolutionary environments, though within universal space and time. In any case it cannot be safely excluded that such a violation could apply to hypernovae from super-massive centres of gravitational re-creation, which events – among other scenarios – might be associated to e.g. active galactic nuclei or to gamma-ray bursts.

Such assumptions are supported in the context of SUM, where a relationship appears between the negative gravitational pressure and a local reduction of entropy. The reason is that the well-established increasing entropy of ordinary gas is always related to its positive pressure which is causing the well-known diffusion in closed overall thermodynamical systems.

Ultra-large scale stationarity, however, demands small local space-time areas of decreasing entropy in addition. No laboratory experience would ever contradict a restriction of the natural increase to evolutionary scenarios, whereas in the cores of supermassive gravitational centres (SGCs), for example, any process of ordinary diffusion is overcome by gravitation and an unrestricted law of entropy may break down.

Furthermore, the possibility for the law of entropy to be restricted to evolutionary processes outside SGCs, is also supported by the well-known, otherwise puzzling, microscopic reversibility of elementary interactions implying the principle of detailed balance. Together with gravitationally disabled diffusion, this balance may turn to a reversal from increasing to decreasing entropy in extreme environments, particularly where the densities of matter and energy would approximate those at a corresponding Schwarzschild radius ('black holes').

Otherwise, in confrontation with the law of entropy each version of big-bang cosmology suffers from the even more fundamental problem concerning the initial singularity without any background described by GR there.

Also in a stationary universe empty space might appear relatively 'expanding', though only with respect to seemingly shrinking local proper-units, and only temporarily again and again. In accordance with the accompanying struggle of ultra-large scale entropic balance against local evolution (s. Section 2.8), there is, on the other side, the well-known struggle of all structures against decline and decay.

In view of SUM it remains the question, how far do the limits of our evolutionary cosmos actually reach out. Where and when does the realm of our physical evolution actually merge into the infinite ultra-large scale universe?

### *C.3.2 Non-Euclidean geometry without real curvature of space and time*

A false argument, claimed again and again, is that gravitation can be only understood as curvature of a relativistic 'spacetime'. This, however, is nothing but a misleading mathematical wording, and physically merely a fiction.

The precession of Mercury's perihelion, for example, does not need anything like a real curved space, but only the gravitational potential of the sun, which – in contrast to Newton's theory – in general is described by 6 symmetric components $g_{ik}$ as combined in the line element of Einstein's GRT. This combination is called the 'metric' because of a suggestive historical mathematical analogy (s. also e.g. [Weinberg 1972]/Sect. 6.9).

According to the SUM concept of universal space and time, however, non-Euclidean geometry is understood to be nothing but the mathematical apparatus to deal with 'proper' rods and 'proper' clocks over non-local scales. This chance has been explicitly accepted by Einstein [1921] himself who in '*Geometry and experience' (Geometrie und Erfahrung*) – only six years after his final formulation of GRT – agreed to Poincaré's [1902] alternative understanding as documented in *'La Science et l'Hypothèse'*.

On the one hand, the behaviour of natural atomic clocks and spectral rods, which are displaying local SRT 'proper' time and local SRT 'proper' length, is undoubtedly governed by quantum mechanics. On the other hand, all physical standards are systematically affected by gravitation and motion relative to the universal frame, whose coordinates are otherwise denoted as 'comoving' or 'conformal' ones. Thus it is completely sufficient to understand non-Euclidean geometry as the tool of affectable rods and clocks without any real curvature of space and time themselves. In this view, 'spacetime' is only another word for GRT's gravitational potential. Accordingly there is also no need for the still prevailing historical interpretation in sense of 'curvature', whose synonymous actual meaning is only the presence of gravitational field strength due to inhomogeneous potentials or simply: of 'gravitation'.

Here the widely accepted Minkowskian concept of a physical 'spacetime' seems even contradictory since special relativity once started from Einstein's fundamental assumption that there cannot exist any physical background like e.g. formerly 'ether'. Though this strict SRT concept has already been broken up with Einstein's [1920] *'Ether and the Theory of Relativity'* (*Äther und Relativität*) its further development remained partially unfinished. In conventional GRT it seems still unclear.

Throughout the SUM context, however, the principle of relativity actually applies to freely falling local inertial frames. It allows the persisting existence of stable objects in spite of gravitationally accelerated motions, which yet locally are of uniform velocities relative to each other.

Since it is found legitimate at least, to understand spatial curvature a gravitational effect on measuring rods instead on mathematical space, the latter therefore can be taken Euclidean at all events. In fact, mathematically, the universal (not to say 'Newtonian') coordinates are nothing but special representations of what is otherwise called 'system coordinates' in GRT.

Accordingly, in the paper on hand the word *relativistic* means *based on Einstein's equations*, but not on his later literally geometric interpretation. That the conventional interpretation is not the only possible one, has been most clearly acknowledged as already mentioned before. In the same article Einstein [1921] stated in unsurpassable clarity: *"As far as the sentences of mathematics refer to reality, they are not safe, and as far as they are safe, they do not refer to reality" (transl. by author)*. This insight might be realized as truly golden rule for all physics (a more convincing speech in favour for a 'natural philosophy' using – or even supervising – 'mathematical principles' seems hardly imaginable).

Therefore, 'curvature', 'flatness', or 'line element' do not necessarily mean real properties of any physical space and time, but rather unnecessarily misleading catchwords for effects of gravitation and universal motion on measuring rods, clocks and on all other tangible objects of physical reality. Here it is essential that besides relative velocities there are 'absolute' velocities, too. Except for a non-existing coordinate centre, of course, the state of movement is uniquely determined with respect to the preferred frame implicitly given by the SUM line element (4) of the stationary background universe.

In addition to all excellent agreement in stellar systems, an extended GRT as understood in the SUM framework seems predestined to describe a stationary universe. There is a self-restoring validity of SRT in accordance with intrinsic limitations of proper length and proper time. As concerns proper quantities at all, these are found to be 'local' SRT concepts only.

### *C.3.3 Not static but stationary: the chance for a 'multiverse'*

When Einstein [1917] developed his first relativistic cosmology, he tacitly took for granted an eternal universe according to what has been called the 'perfect cosmological principle' in the SST later. In the meantime, with Friedman(n) [1922/24], relativistic cosmology had turned to temporal evolving solutions of Einstein's equations. These solutions were supported by Hubble's [1929] law, which before (after Slipher's early discovery of galaxy redshifts) has been actually found in 1927 by Lemaître. Once the 1917 cosmological constant was finally discarded by Einstein & de Sitter [1932] a pressureless flat-space model (EdS) has been proposed. In contrast to previous approaches, then Bondi & Gold [1948] as well as in particular Hoyle [1948/49] tried to reconcile Lemaître's [1931a/b/c] 'expanding' universe with the concept of a 'steady state', which model soon after was deplored almost hastily to conflict with observational facts (for details s. [Hoyle, Burbidge, & Narlikar 2000], or e.g. Weinberg [1972]). What might have been misunderstood with Einstein's equations?

Einstein's homogeneous and isotropic large scale universe attempt of 1917 should have been completely determined by its average densities of energy and pressure, though ad hoc with help of a 'cosmological constant'. While in sense of natural philosophy he was clearly right to assume a universe without peculiar history, he was unfortunately focused on a static solution solely. This, however, is an unnecessary assumption. At those times it has been correspondingly assumed that stable radiationless atoms should be static, while the characteristic feature in both cases now turned out to be stationarity after all.

This stationarity, however, does not at all mean literally a 'steady state', but a lively process instead. Thus in contrast to 'static', here the term 'stationary' has to be understood to describe an eternal background where, necessarily in an on-going interplay with quantum mechanics – resulting in local gravitational re-creation events – each evolutionary cosmos may take a limited life time.

Since even this model implies a maximum age of macroscopic universal structures, there arises the question again whether SUM can keep unquestionable achievements of today's standard cosmology without suffering from its various problems. No external hypotheses are needed to reach compatibility with basic observational features, which otherwise had to be developed in the CCM framework only speculatively before. Prominent examples are spatial flatness, or the alleged 'age of the universe' just equalling the Hubble time $T_{H(0)} \equiv 1/H_{(0)}$ [the latter relation has been shown also to determine heuristically the approximate numerical value of the 'cosmological constant' in the CCM framework (s. Section 3.0)].

Accordingly, what otherwise is labelled 'age of the universe', now in view of the SUM has turned out to be rather that 'maximum age of macroscopic structures'. A re-creation of light elements corresponding to the CCM concept of 'primordial nucleosynthesis' – as well as other relevant physical knowledge and models which at present are ascribed to one singular hot 'big bang' – might apply to local processes instead. Lemaître's [1931c] 'primeval atom' would have been in a universal multiplicity, though not as a mere singularity (this non-physical overstatement has been assumed only later). Several singularity theorems of GRT do not apply once QM is taken seriously into account. Contrary to the 'single-bang' concept underlying the CCM, there is the suggesting possibility of 'multi-bang' events instead, which may have taken – and will take – place within the stationary background universe.

Considering Einstein's initial cosmology on the one hand and the Steady-State Theory on the other hand as historical alternatives to today's CCM, one finds oneself almost constrained to accept SUM instead.

If the fundament of relativistic cosmology shall be more than fiction there must have been a physical background behind the big-bang cosmos. Only the latter is subject to the CCM while the former is actually missing in its otherwise coherent mathematical framework.

It is of interest in its own right that there is a stationary solution of Einstein's equations (essentially different from the various versions of the SST), now implying unexpected features concerning relativity theory itself, which essentially contradict several assumptions of the early models.

Without any unproven physics, the SUM line element yields magnitude-redshift relations which obviously describe the Supernovae Type Ia (SNe-Ia) data on universal scales $z > 0.1$ straightforwardly. At the same time, it offers a solution for the most puzzling problem of 'dark energy' unnecessarily caused by the CCM.

Now there is an at least mathematically perfect solution for a CMB black-body background composed of redshifted radiation emitted within the non-expanding universe.

Since the SST was found incompatible to cosmological facts, there might have been little interest in another attempt to overcome a singular universal origin at all, as long as there has been no observational indication. Therefore the various figures in the text are important to demonstrate the relevance of SUM as the new concept presented here.

Quite naturally, there are not only differences between SUM and SST [including the later Quasi-Steady-State Cosmology (QSSC)], but according to clearly related aims also several things in common. For example, the SST approach has led to exceptional achievements concerning nucleosynthesis (not only the otherwise lacking understanding of the synthesis of heavy elements in stars [Hoyle, Burbidge, & Narlikar 2000]). In one of both original SST papers, Hoyle introduced a universal scalar field into the framework of GRT, thus effectively anticipating the CCM concept of cosmic 'inflation'. Some other features of the later QSSC may possibly prove applicable, though with essential modifications in the SUM framework. In particular, 'creation centres' of the QSSC might correspond to 're-creation centres' here. Instead of a *C*-field in the SST, there might be an equivalent in the conversion of gravitational energy described by $_{(\mathrm{bi})}t_i^{\,k}$ to the energy-stress-momentum tensor of matter $T_i^{\,k}$ from the perspective of SUM.

It seems that only the stationary solution SUM offers the chance of keeping a modified CCM as a description of our cosmos without having to assign all of its implausible features to the entire universe. Particularly this concerns the well-known problems from strange 'coincidences' and 'fine-tuning'. In any case the new model may help clarify the history and the shape of our cosmic environment – or simply of 'our cosmos' – by distinguishing peculiar CCM features from the ultra-large scale SUM background.

In the system of universal ('comoving') coordinates, with respect to which the galaxies are statistically at rest, the Concordance Cosmos is estimated to span around seven times the Hubble length $c/H_{(0)}$. What would be there beyond this distance, if not space and time for other cosmoses? Existing within a *one and only infinite multiverse*, however, these 'local' cosmoses would have nothing to do with fictions of separated 'parallel universes' allegedly connected by unreal 'wormholes of spacetime'. Occam's razor is well applicable to cancel unnecessary assumptions in the interpretation of *special* as well as of *general* relativity theory.

Free of any coincidences or horizon problems and with no need for a *universal* phase of inflation, the SUM is capable of embedding our own evolutionary cosmos into an upcoming stationary 'tohu-va-bohu' multiverse background cosmology. Actually no explicit line element other than that of SUM has been found to provide such a background (also for assumed 'vacuum fluctuations', if necessary).

It seems almost a miracle after all, that on basis of Einstein's equations the idea of an *infinite* stationary universe turns out to imply clear indication that individual cosmic structures are of *finite* dimensions. It is in particular this conclusion that arises from the interplay of local special relativity (macroscopically representing quantum mechanics) and universal general relativity (representing gravitation). While the unexpected feature how the same mathematically structured model – describing our cosmos as part of a stationary universe – brings ideas of various cultural areas to mind about existence and creation, these ideas seem implausibly unbalanced in the prevailing single-bang standard cosmology.

Started from a deductive SUM approach, here Einstein's equations are found ready to support a dynamic multiverse model of the stationary ultra-large scale background.

### C.4 Some concluding remarks on the SUM concept, its origin and related earlier attempts

The SUM concept has been developed since 2001 [Ostermann 2003, 2004, RKQ08, 2012a/b, SUM14] looking for a *stationary* line element of GRT in infinite Euclidean space and in infinite universal time. In contrast to real potentials or fields, both are presupposed to be mathematical concepts without physical properties. The stationarity of this model – primarily evident from its unchanging redshift parameters for objects without 'peculiar' motions – is supported by the self-restoring validity of SRT within 'local' inertial frames.

This new model is thought to describe the universe on ultra-large scales where the underlying assumptions of isotropy and homogeneity seem actually justified. In line with this objective a comparison with the SNe-Ia data, the CCM, and its 'parents' EdS and SST, revealed straight SUM applicability on scales $\mathrm{z} > 0.1$ (Section 3). According to the local limitations of SRT concepts and processes (Section 2.4) there is, the other way round, indication that an on-going re-creation in 'local bangs' might affect only coherent scales of corresponding dimensions $\mathrm{z} \approx 0.1$, at most up to $r^* < R_H$ (what would mean $z < 1.7$ if without additional contributions to redshift).

Full scale SUM compatibility with the SNe-Ia data has been obtained taking into account possible peculiar features of our 'local' cosmic environment like in particular a Hubble contrast within that range (Section 3.2).

An apparent problem for straight SUM so far is the lack of a detailed explanation for the CMB anisotropies. The relevant measurements, with increasing precision from COBE, WMAP up to the PLANCK 2015 results, provide collectively excellent numerical support for the CCM except e.g. the SZ cluster count prediction mismatch (Section 6) or the Hubble constant dilemma (Section 3.2). The other way round, these measurements do not exclude a stationary background, where the CMB anisotropies may be caused by DM oscillations or inhomogeneities due to halos, but are not yet explicitly resolved.

As clarified in Appendix C.3.3 the SUM line element (4) is not static of course. That in spite of its special dependence on time – which may need getting used to – it is rightly qualified as stationary, follows from the calculation of its characteristic features. These had to be repeatedly addressed because of unaccustomed mutual relations. In particular, the SUM concept has been shown to include, that:

a) … the redshift parameters $z = \mathrm{e}^{Hl^*/c} - 1$ are independent of time for galaxies statistically at rest;

b) … all universal observables which are functions of $z$, are also independent of time;

## TABLE 1

The Stationary Universe Model (SUM) in comparison with the current Cosmological Concordance Model (CCM)

| ***Some characteristic FEATURES (list extensible)*** | **Model of a STATIONARY BACKGROUND UNIVERSE (SUM)** | **Concordance/Consensus Model of OUR COSMOS (CCM)** |
|---|---|---|
| *line element*<br>- - -<br>*scale factor* (for $\Omega_{\mathrm{rad}}=0$) | $\mathrm{d}s^*_{\mathrm{SUM}} = \mathrm{e}^{Ht^*}\mathrm{d}s^*_{\mathrm{SRT}}$<br>- - -<br>$a_{\mathrm{SUM}} = 1+Ht'$ | $\mathrm{d}\sigma^2_{\mathrm{CCM}} = c^2\,\mathrm{d}t'^2 - a^2_{\mathrm{CCM}}\,\mathrm{d}l^{*2}$<br>$a_{\mathrm{CCM}}(t')=\left\{\left(\frac{1}{\Omega_\Lambda}-1\right)\sinh^2\left[\frac{1}{2}\ln\left(\frac{1-\sqrt{\Omega_\Lambda}}{1+\sqrt{\Omega_\Lambda}}\right)-\frac{3}{2}\sqrt{\Omega_\Lambda}\,Ht'\right]\right\}^{1/3}$ |
| $t^*$, $l^*$ | universal time, universal space | conformal time, 'comoving' space |
| *model parameters* | natural constants $c$, $G$, $H$ | independent parameters<br>$T_0$, $H_0$, $q_0$, $\Omega_0$, $\Omega_{\mathrm{M}}$, $\Omega_\Lambda$,<br>(several additional parameters of inflation) |
| *cosmological constant* (*dark energy*) | – none –<br>(homogeneous background of 'dark' matter) | $\Omega_\Lambda \approx 0.73$, value coincidental if not determined by SUM 'boundaries' |
| *redshift of starlight from sources at rest* (*in 'comoving' coordinates*) | $z = \mathrm{e}^{Hl^*}$, where $l^* = \mathrm{constant}\|_{t^*}$,<br>independent of time,<br>directly showing stationarity$^{*)}$ | $z = z(t', l^*)$,<br>dependent on time<br>[as well as all functions of $z$, e.g. $H(z)$, $q(z)$, …] |
| $H$ | galaxies at rest in the universal ('comoving') frame imply $H_{\mathrm{s}} \equiv \dot{a}$ with the constant<br>$H \equiv H_{\text{s-SUM}}$<br>as the *significant* Hubble parameter | both the significant parameter $H_{\text{s-CCM}}$ as well as the *conventional* Hubble parameter<br>$H_{\text{c-CCM}}(t') \equiv \dot{a}/a$<br>depend on time |
| *space and time* | $\equiv T_H$, $R_H$ maximum age/radius of structures subject to any SRT concepts | $T_0 \approx T_{H0}$ the age, $R_0{}^* \approx 3.4\,R_{H0}$ the radius of 'the universe' today |
| $H_0 T_0$ | $HT \equiv 1$ due to stationary values<br>$H_0 \equiv H$ and $T_0 \equiv 1/H$ | $H_0 T_0 \approx 1$ coincidentally today<br>(a temporary value) |
| *'deceleration' parameter*<br>$q \equiv -a(\mathrm{d}^2a/\mathrm{d}t^2)/(\mathrm{d}a/\mathrm{d}t)^2$ | according to postulate I of stationarity*:*<br>$q \equiv 0$ | assumedly *positive* after 'big bang',<br>*negative* while inflation,<br>then *positive* for some $10^9$ years,<br>*negative* today again (uncertain for the future) |
| *initial singularity* | none with respect to universal coordinates, local pseudo-singularities instead, modified by quantum mechanics (breakdown of proper length and time) | unexplained origin in one 'big bang' concerning the entire universe, or 'big bang' from e.g. chaotic inflation within a background unexplained in GRT |
| *spatial flatness* | deduced from postulate II of a constant universal speed of light $c^* = c$ | approximately after a phase of 'superluminal inflation' |
| *horizon problems* | none | overcome by 'superluminal inflation' |
| *law of entropy* | restricted to *any* evolutionary environments | restricted to *one* evolution after 'big bang' |
| *'black holes'* | supermassive (active) gravitational centers,<br>'bright sources',<br>QM retains matter from vanishing forever | limits of phenomenological GRT-applicability like e.g. the Schwarzschild-radius (accepted there to limit physical reality again) |
| *CMB* | from homogeneously distributed 'dark'-matter, (anisotropies, acoustic oscillations, voids, halos) | 'big bang' relic radiation, anisotropies caused by acoustic oscillations (ad-hoc fitted inflation) |
| Sunyaev-Zeldovich effect | reduced to higher values of $z$, with gradual shift, (direct agreement at low-z clusters) | undiminished signal, indpendent of redshift (Planck-15 cluster count mismatch, 'dark flow'?) |
| *n-bamg nucleosynthesis* | ongoing re-creation from 'local-bang' events in the stationary universe (multiverse) | only one 'big bang' of the entire universe |
| *straight-off compatibility with the SNe-Ia data* (if *local Hubble contrast…*) | $0.1 < z < 1.8$<br>excluding the local region z < 0.1<br>(… then $0.01 < z < 1.8$) | $0.01 < z < 1.8$<br>the full range of observational data<br>(… then $0.025 < z < 1.8$) |

NOTE. – $^{*)}$ The stationary model SUM should not be confused with the 'Steady-state' Theory (SST) whose e.g. redshift parameters depend on time.

c) … all universal distances $l^*$ – statistically measurable by stationary values of $z$ – simply stay unchanged;

d) … the magnitude-redshift relations for 'standard candles' like type Ia SNe are independent of time;

e) … because of the exponential form of the time scalar $e^{Ht^*}$ in (4), all relative temporal changes depend solely on differences $\Delta t^* = t_A^* - t_E^*$, what allows to set any reference point of universal time $t_R^* = 0$ for coherent complexes of observation;

f) … the stationary SUM line element, implying a constant universal speed of light $c^* = c$, corresponds to the simplest of all general FLRW-forms without cosmological constant;

g) … the stationary 'deceleration' parameter is $q(t') \equiv 0$;

h) … both, the covariant EMS tensor $T_{ik}$ of matter as well as its contravariant density $\mathbf{T}^{ik}$, are constant, what – taken together with galaxies statistically at rest – coincides with a conservation of universal mass-energy;

i) … in addition to $c$ and $G$ – completed by the microscopic constants $e$ and $h$ – the law of universal redshift includes $H_{\text{s-SUM}} \equiv H$ as a significant Hubble *constant*, which seems to coincide with a claim that the Schwarzschild radius $2GM_H/c^2$ of the 'Hubble mass' $\rho_c \cdot 4/3\pi R_H^3$ should equal the 'Hubble radius' $R_H \equiv c/H$ most naturally. This claim might be understood, the other way round, as a determination of the gravitational constant from $H$ and $\rho_c$, the latter density a necessary condition for any flat-space background universe.

In view of the probability that several tentative SUM assumptions will apply, it might be reasonable, temporarily to accept even a 'missing link'. For comparison, the most essential features of SUM are directly confronted against those of ΛCDM cosmology in Table 1. Thus an unbiased consideration may help to find out how many hypotheses are necessary to mathematically describe the universe, and which of them are plausible in view of proven physics.

Regarding earlier attempts, as for example various versions of what has been called 'Steady-state Theory', or a 'Coasting Cosmology', there are essential inconsistencies.

At first sight, it appeared that any stationary approach must fail since the SST finally turned out to conflict with the SNe-Ia observations, too (Section 3.2). In spite of its reasonable intention however – which according to the original concept has been concentrated on a 'perfect cosmological principle' – this theory is not convincingly stationary at all. For example, its individual redshift parameters as the fundamental cosmological observables are $z_{\text{SST}} = e^{H\Delta t'} - 1$ with $\Delta t' = r^*/c'$ the light time, thus due to the time-dependent SST coordinate velocity $c' = c/e^{Ht'}$ not constant. A simple calculation yields $z_{\text{SST}} \approx H/c \cdot r^* e^{Ht'}$ where $r^*$ would be a literally comoving distance to a galaxy and $t'$ the 'cosmic proper time' of the respective redshift measurement.

In contrast to SUM with its clear stationarity of (37), the SST kept on claiming proper distances together 'with cosmic proper time' as valid measures for arbitrary intervals of universal space and time, what has been disproved in Section 2.4. This historical approach, in logical accordance to its presuppositions, has been already clear from the titles *"The Steady-State Theory of the Expanding Universe"* [Bondi & Gold 1948] and *"A New Model for the Expanding Universe"* [Hoyle 1948/49] of the original papers.

To keep the impression of a 'steady state', these authors had to claim an on-going spontaneous creation of matter filling the gaps all over the universe (it seems another puzzling question, though, how new galaxies might find their appropriate positions each to share the 'Hubble flow' then).

Concerning the CMB there has been discussed an origin from stellar radiation thermalized by e.g. iron whiskers in the SST framework. Here it would be impossible, however, to keep a Planck spectrum of pure redshifted black-body radiation coming from cosmic distances.

There are other differences from SUM as for example regarding a horizon for light signals limiting the region of receiving in future. According to the SST this horizon would equal the Hubble length $c/H$, while according to SUM there is no horizon concerning the universe at all. If in Table 1 the CCM had been compared with the SST instead of the SUM, then the picture would have looked completely different in favour of ΛCDM cosmology.

Historically, in addition to today's standard cosmology, there has been a chaotic inflationary approach where some early papers once also referred to a "stationary universe model" [Mezhlumian 1993/94], [Linde & Mezhlumian 1993], [Linde, Linde, & Mezhlumian 1994]. Besides this heading expressing a corresponding intention, however, that approach is quite different from the SUM proposed here. Instead, it seems to give rise to those disconnected 'parallel universes' of inflationary scalar fields mentioned above. Each of them should be described by a variant of today's ΛCDM model respectively. But it may be stated without further reasoning that, though it is possible to count beans, it does make no sense to count 'universes'. The one fundamental line element of general relativity to describe a coherent background is missing.

On the other hand, in view of SUM, it is a large advance of that 'chaotic inflation' concept [Linde 1983] to have established something like a universal background at all, though only in form of mere quantum fluctuations [Mukhanov & Chibisov 1981]. Nevertheless the concept of a singular 'big bang' has been effectively overcome there.

Following another track, a more general FLRW form than (47), including spatial curvature, once has been named "Coasting Cosmology" by Kolb [1989], before subsequently a closely related concept has been discussed many years later by Melia & Shevchuk [2012] in the big-bang framework again. Both approaches are fundamentally different from SUM, though if Kolb's line element was specialized to flat space, it would mathematically take the same FLRW-form, misleading in that context, however. In view of an assumed coasting expansion of the entire universe, thus unfortunately adhering to the overcome concept of unlimited universal 'proper' length and 'proper' time, most fundamental stationary features of SUM remained unrevealed. In particular, the fundamental result of redshift parameters independent of time, has not even been stated there. If at all, this might have been rather regarded a 'Steady-state theory of a coasting universe' [SUM14/A1].

Einstein's discovery of gravitational redshift dates back to 1911 as a consequence of his fundamental equivalence principle. After the explicit caveats by Hubble, mentioned in Section 2.5, it seems confusing or even unworthy for serious physics to have systematically forgotten that there could be an alternative explanation for the cosmic redshift instead of a fictitious universal expansion. Therefore the historical concept needs long-winded explanations to answer the simple question of *one* actual physical velocity of e.g. the Andromeda galaxy mass centre, because there had to be *two* essentially different summands (one due to 'peculiar' motion *plus* one due to the unnecessarily assumed 'Hubble flow'). It is difficult to understand how in spite of his equivalence principle – with SRT explicitly valid in *local* inertial frames – Einstein apparently ignored the chance for an appropriate transfer of Hubble's caveats in the sense of ordinary gravitational redshift. Otherwise he probably would have never accepted Lemaître's "abominable" (his wording) concept of an expanding universe. The only reason seems to have been the unjustified adherence to the naive original SRT concepts of 'proper' length and 'proper' time, which without limitations are overstrained in conventional GRT (s. Section 2.4).

To argue along the traditional lines of relativistic cosmology, the stationary 'deceleration' parameter, in general defined as $q(t') \equiv -a\,\ddot{a}/\dot{a}^2$, is found $q_{\mathrm{SUM}} \equiv 0$ as it must be. This value has been interpreted according to Kolb`s concept of the 'coasting' expansion above, though without the postulate of spatial flatness equivalent to a constant universal speed of light $c^* = c$. In addition, there is also missing the universal line element (4), whose form immediately corresponds to a stationary embedding of SRT, or other essential features of the SUM presented here.

The observations of the last decades may be seen approximately to support a double mean zero $k \equiv 0$, $q \equiv 0$ in line with SUM. In strange contrast, the CCM 'deceleration parameter' is claimed to be $q < 0$ today, after $q > 0$ in the past, though only with $q \ll 0$ while inflation.

In accordance to SUM as the cosmological model of general *and* special relativity theory, there would be alternating processes of evolution and revolution all over the universe, the latter processes possibly in quasars, 'black holes', SMOs and AGNi, hot core structures before blown up to bubbles, or also in hypernovae leading even to 'local-bang' cosmoses, which respectively are the largest structures of conjoint local origin.

Initially SUM has been developed since 2001 (s. references above), while both the 'Coasting Cosmology' as well as the earlier 'chaotic inflation' approach have been unknown to author. The reason may be, that expanding space at all, as well as e.g. later any concept of completely separated 'parallel universes', would basically contradict necessary presuppositions of an acceptable 'natural philosophy' (though proponents of standard cosmology would probably never speak of any philosophy in this context). Now plausible presuppositions had to replace the network of hypothetical 'big bang' speculations from the beginning.

Though in ΛCDM cosmology the fundamental line element (4) describing *one* coherent background universe is absent, it cannot be firmly excluded that an attempt to 'embed' the evolutionary CCM cosmos into the SUM framework might bring different approaches together.

The chronological order, that the stationary solution SUM was found only after the SNe-Ia data had been published (but still without knowledge of them) may be why it remained nearly unnoticed so far. Otherwise these data might have immediately confirmed a SUM prediction on universal scales . Instead, a suitable amount of a hypothetical 'dark energy' corresponding to a cosmological constant of about 70% the critical density has been established in the meantime.

On the one hand, without the invaluable SNe-Ia measurements the SUM concept would have not been developed to an arguable level. On the other hand, without the conscientious evaluation of the 2015 SZ data by the PLANCK collaboration the chance to elaborate this concept – and possibly to test it – would not have arisen.

At present it may seem unlikely that SUM as the stationary universe model could overcome today's exceptionally successful ΛCDM cosmology even if it will definitely prove a better alternative one day. Nevertheless, in view of serious physics there is a scientific obligation to try it. Time and again, the troublesome historic shift from the geocentric to the heliocentric model of our planetary system gives encouragement, in that it taught natural science not to be dogmatically sure about a model even if it was highly developed and numerically convincing for decades or centuries. The more fundamental a model, the more important is a repeated unbiased review of its foundations.

In the CCM framework, the predominant contribution of 'dark energy' is a complete mystery. Also the concept of a dark matter without non-gravitational interaction seems compromised to fail. A failure of the Λ-'cold-dark-matter' concept, however, would obviously undermine the big-bang cosmology of a singular universal origin at all.

Though it can be expected that an explanation for the PLANCK 2015 model prediction mismatch of Sunyaev-Zeldovich cluster counts can be found due to the 'artistic skill', developed within the highly adaptable ΛCDM framework over decades, there remains the intellectual challenge to falsify the SUM approach without any big-bang priors. Trying this, the exceptionally successful CCM has to be reviewed against the fundamental alternative in question even if only to resolve remaining serious doubts. This all the more because SUM as the mathematically simplest conceivable concept of relativistic cosmology seems anything but incompatible to the fundamental observational facts.

In contrast to ΛCDM cosmology it would cause no insurmountable difficulties for SUM – just the contrary – to dispense with an unprovable single-bang origin of the entire universe, an ad-hoc invented temporary phase of inflation, an assumed 're-combination' (then compensated by 're-ionization'), the baryon asymmetry dilemma, or several problems of high precision CMB measurements concerning e.g. a giant cold spot, low-multipole alignments, a reported 'dark flow', or two different values for the Hubble 'constant' (among others).

Even independently from the treatment in SUM, now using the statistics of the Sunyaev-Zeldovich effect with the PLANCK 2015 data on hand, there has come the possibility to decide whether or not the CMB once originated at $z > 1000$ after a 'big bang', or whether, the other way round, the CMB is emitted from dark matter within a non-expanding background universe.

With the chance for a conceivably overdue paradigm change looking back, it seems useless to speculate how it ever became possible to accept a modern 'mathematical tale of creation' as a basic model for serious physics. In addition to overwhelming discoveries and mind-opening achievements of observational cosmology in the last decades, now new or on-going evaluations, future telescopes, and perfected devices – together with still enhanced measurements – will decide after all. The risk has to be taken into account, however, that in spite of even higher precision several phenomena, if taken separately without the respective fundamental context, might stay ambiguous in their interpretation.

A natural reason is, that the universe is not so simple a thing how today's mainstream cosmology would readily assume it to be. Actually the best opportunity for a provisional quick decision between standard cosmology and particularly the CMB alternative presented according to the SUM approach above should be to evaluate the SZ data streams still split up for each distinct PLANCK frequency channel on its own. The question is whether there could be found a statistically restricted applicability of the conventional SZ cluster search procedure corresponding to the panels of Figure 8 (Section 6.1). Then would possibly follow a complete evaluation in the full SUM framework together with a new explanation of the CMB anisotropies.

A quotation of Thomas S. Kuhn's ″Structure of scientific revolutions″ may conclude this brief historical appendix: *″... to be admirably successful is never, for a scientific theory, to be completely successful.″* Obviously this statement concerns not only the past but also the future.

No new model could ever be claimed to apply immediately in all its various aspects. As compared to the development of today's ΛCDM single-bang cosmology – now almost substantially different from the original big-bang theory – there remains a lot of disposable adaption space also for SUM. Therefore the only arguable alternative based on Einstein's original equations demands a scientific discussion instead of an endless sham fight in confrontation of the CCM against the outdated 'Steady-state Theory'. On the other hand, an unbiased endeavour will be necessary to improve the SUM concept, at first by fixing what is erroneous, lacking, or still unclear. In view of the universe being subject, it is obvious that the latter chance needs public cooperation