RELATIVISTIC DEDUCTION OF A STATIONARY TOHU-VA-BOHU BACKGROUND COSMOLOGY*

PETER OSTERMANN

peos@independent-research.org

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

Two simple postulates are used to deduce the one and only stationary solution of general relativity[1–3] implying redshift parameters z independent of time (thus in contradiction to the so-called 'Steady-state'-Theory) as well as a constant universal speed of light $c^* = c$ (s. below). It is shown that the model's gravitational 'dark' pressure of $-1/3$ the critical density must be negative, corresponding to a stationarily changing cosmological constant.

There is a struggle of local SRT (representing quantum mechanics) and universal GRT (representing gravitation). In particular, intrinsic limitations of proper length and time are derived, which would cause a stationary background universe to be anything but static, i.e. not a state but a (chaotic) process. — The postulates are:

Postulate I: The universe is stationary, homogeneous, and isotropic, though on scales large enough only (with H a significant Hubble *constant*, s. below).

Postulate II: Except for deviations caused by local inhomogeneities the universal coordinate speed of light c^* is constant [i.e. $c^* \equiv dl^*/dt^*(\mathrm{d}\sigma^*_{\mathrm{SUM}} = 0) = c$].

They determine the line element of the stationary universe model (SUM) to be

$$\mathrm{d}\sigma^{*2}_{\mathrm{SUM}} \;=\; \mathrm{e}^{2Ht^*}\mathrm{d}\sigma^{*2}_{\mathrm{SRT}} \;\equiv\; \mathrm{e}^{2Ht^*}\left(c^2\mathrm{d}t^{*2} - \mathrm{d}l^{*2}\right)\;, \tag{1}$$

implying spatial flatness (an asterisk means *universal* coordinates, i.e. a special case of what is called 'conformal' time, t^*, and 'comoving' space $\vec{r}^*$).

More general, there might apply an embedded line element

$$\mathrm{d}\sigma^* \;=\; \mathrm{e}^{H(t^*,\,\vec{r}^*)t^*}\mathrm{d}\sigma^*_{\mathrm{GRT}}\,, \tag{2}$$

where $\mathrm{d}\sigma_{\mathrm{GRT}}$ is determined by the vacuum equations $R_{ik} = 0$ and, with $\overline{H^2(t^*,\,\vec{r}^*)} \equiv H^2$, relation (2) averaged over universal scales of space and time yields (1).

Because of the exponential time scalar e^{Ht^*} in (1), all relative temporal changes depend on *differences* $\Delta t^* = t^* - t^*_0$ solely. Therefore, no singular point t^*_0 of the universal time scale is preferred. According to (1) atomic clocks at rest (with respect to the universal coordinate frame) show local proper time and local proper length

$$\begin{aligned}\mathrm{d}t_{\mathrm{SRT}} &\approx \mathrm{e}^{Ht^*}\mathrm{d}t^*\;,\\ \mathrm{d}l_{\mathrm{SRT}} &\approx \mathrm{e}^{Ht^*}\mathrm{d}l^*\;.\end{aligned} \tag{3}$$

---

* *The original pdf-sheets of this COT3-Talk (21 pages, 2 figures, 20 equations) are available from ⟨independent-research.org⟩ as well as a corresponding COT2-Talk, too. Please use those detailed versions for checking results, development, and more implications of the model presented here.*

Taking into account the light time $\Delta t^* = l^*/c$, the usual definition $z \equiv \lambda_{\rm observed}/\lambda_{\rm emitted} - 1$ leads to redshift parameters independent of time:

$$z = \mathrm{e}^{Hl^*/c} - 1 \quad \Leftrightarrow \quad l^* = \frac{c}{H} \ln(1+z) \ , \tag{4}$$

what applies to galaxies statistically at rest, i.e. $l^* = constant\,|_{t^*}$ (or with respect to the Cosmic Microwave Background if universal indeed). This means in addition to local 'proper' length $l_{\rm SRT}$, the universal quantity l^* is a real physical distance measure since it is actually an immediate measurand by time-independent values of z. — The SUM energy-stress tensor given by Einstein's equations may be written in the form

$$E_{ik}^{*\,\rm SUM} \ = \ \begin{pmatrix} \frac{2H^2}{c^2} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} - \kappa p^* g_{ik}^* \ = \ \kappa \, T_{ik}^* \ , \tag{5}$$

thus demanding a negative 'dark' *gravitational* pressure $p^* = -\rho^*/3$ where $\rho^* \equiv T_0^{0*} = \rho_c \, \mathrm{e}^{-2Ht^*}$ is the full energy density. Obviously p^* corresponds to a stationarily changing cosmological 'constant'. To state it explicitly, this gravitational pressure must be negative because the walls of a large-scale box including a plenty of galaxies at rest, would have to pull *outwards*, if those inside should not mass together after those outside had been removed.

With respect to (5) the phenomenological density of *matter* is only $\mu^* = \frac{2}{3}\rho^*/c^2$ (therefore the difference $-p^* = \rho^*/3$ to the full *energy* density ρ^* is 'dark').

Since the redshift parameters z are independent of time for sources at rest, so are the magnitudes and all other quantities, too, which are functions of z.

There are intrinsic limitations of proper length and proper time. According to the line element of special relativity theory (SRT) within local inertial frames, $\mathrm{d}\sigma_{\rm SRT}^2 = c^2 \mathrm{d}t_{\rm SRT}^2 - \mathrm{d}l_{\rm SRT}^2$, the intervals $(\mathrm{d}t_{\rm SRT}, \mathrm{d}l_{\rm SRT})$ of proper time and length are defined necessarily *together*. From (3), integrated coordinates (r', T') implicitly given by

$$t^* \equiv \frac{\ln(HT')}{H} \ , \quad r^* \equiv \frac{r'}{HT'} \tag{6}$$

transform the stationary line element (1) approximately into that of SRT

$$\mathrm{d}\sigma_{\rm SUM}'^2 = \left[1 - \left(\frac{r^*}{R_{\rm H}}\right)^2\right] c^2 \mathrm{d}T'^2 + 2\left(\frac{r^*}{R_{\rm H}}\right) c \mathrm{d}T' \mathrm{d}r' - \mathrm{d}r'^2 - r'^2 \mathrm{d}\Sigma'^2 \ , \tag{7}$$

as long as $r^* \ll R_{\rm H}$, where $R_{\rm H} \equiv c/H$ and $\mathrm{d}\Sigma' \equiv \mathrm{d}\Sigma^*$ the element of a Euclidean spherical surface. — If without the universal distance r^* only the universal time t^* had been transformed this would have resulted in a Friedman-Lemaître-Robertson-Walker (FLRW) form. Thus, to more easily compare the SUM with other models as in particular today's Cosmological Concordance Model, the stationary line element (1) may be rewritten as

$$\mathrm{d}\sigma_{\rm SUM(FLRW)}^2 \ = \ c^2 \mathrm{d}T'^2 - a_{\rm SUM}^2 \left(\mathrm{d}r^{*2} + r^{*2} \mathrm{d}\Sigma^{*2}\right) \tag{8}$$

where the scale factor is $a_{\rm SUM} \equiv HT'$, without thereby changing any physical results, of course. It is easily verified that in particular the Hubble relation (4) holds from (8) in its time-independent form, too (in contrast to the *conventional* Hubble parameter $H_{\rm c} \equiv \dot{a}/a$ the *significant* value is $H = H_{\rm s} \equiv \dot{a}$, since by definition not l but $l^* = constant|_{t^*}$ for galaxies without peculiar motions).

This FLRW-form (8) is no longer without singularity. However, it is important to see from (7) that

$$r^* \overset{!}{<} R_{\rm H} \tag{9}$$

is setting an upper limit for the validity of the SRT-relations (3). Therefore the integrated time T' as a quasi-Minkowskian coordinate approximation to a *local* proper-time integral $t_{\rm SRT}$ is not at all suitable to hold at or beyond universal distances $r^* \approx R_{\rm H} \equiv c/H$. Accordingly the coordinate time T' of any FLRW-form cannot be a uniform proper time all over the universe because proper time is always given within *local* cosmic areas only, limited to extensions described by (9).

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 time approximately apply. The condition $T' > r'/c \geq 0$ equivalent to (9) means that there shouldn't be any local structures older than $T_{\rm H} \equiv 1/H$ with respect to their proper time. Thus $T_{\rm H}$ has not necessarily to be the age of the universe as a whole. What is called expansion of space, may the other way round be understood a universal condensation of material structures arising again and again.

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

It has to be stated that given a stationary background universe — this view seems supported by the Supernovae Ia magnitude-redshift observations (s. the COT2-Talk mentioned above* and references therein) — hot originative 'local bang' events would violate an unrestricted validity of the law of entropy. A big-bang origin of the universe as a whole, however, had violated *all* physical laws.

Altogether, if necessary, the SUM presented here — free of any coincidences or horizon problems and with no need for a *universal* phase of inflation — seems capable of embedding the evolutionary cosmos described by today's Concordance Model into the Stationary Tohu-va-Bohu Background Cosmology, too.

References

1. Ostermann P., Ein stationäres Universum ... , *arXiv.org/physics/0211054* (2002/03).
2. Ostermann P., ... a Stationary Universe, *arXiv.org/astro-ph/0312655* (2003/04).
3. Ostermann P., *Zu Relativitätstheorie, Kosmologie und Quantenmechanik*, digIT 2008.