The Electron and Weak Points of the Metric System

Gerd Pommerenke

Email: gerdpommerenke@arcor.de

Abstract

Object of this work is to find out the reason, why we get only nearly correct results with calculations using natural constants. The possibility to increase accuracy is analyzed in order to obtain more exact results than with the CODATA values. A special role in this connection plays the electron.

The calculations are based on the model published in [1] and as the latest version in [6]. The idea stems from Cornelius LANCZOS, outlined at a lecture on the occasion of the Einstein-Symposium 1965 in Berlin [2]. The model defines the expansion of the universe as a consequence of the existence of a metric wave field. That field also should be the reason for all relativistic effects, both SR and GR.

In the context of this work the properties of the electron are analyzed with the result, that it's well suited as a scale basis of the metric system. Furthermore some weak points of latter one have been found, being the reason for the imprecise results when using the CODATA values. The reason are fixed values used to the definition of base units, which in turn depend on other values as well as on time and on the reference frame. In the end a consistent system is presented, which yields exact results of the basic natural constants, with which nearly all other natural „constants" can be calculated by means of five fixed values only. The bottom line is the meaning of the PLANCK-units and the electron mass as glue to the reference frame. Exactly set up the system would allow the calculation error to be reduced to almost zero, as the errors of different measured values are not "passed through".

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1. Preamble

Object of this work is to find out the reason, why we get only nearly correct results with calculations using natural constants. The possibility to increase accuracy is analyzed in order to obtain more exact results. The calculations are based on the model published in [1] and in latest version in [6]. The idea stems from Cornelius LANCZOS, outlined at a lecture on the occasion of the Einstein-Symposium 1965 in Berlin [2]. The lecture is also prepended the work in [1].

The model defines the expansion of the universe as a consequence of the existence of a four-leg-field, being the reason for all relativistic effects, both SR and GR. Its temporal function is based on the hypergeometric function ${}_0F_1$. The special properties of that field lead to an increase of the wavelength. The phase angle $2\omega_0 t = Q_0$, being identical with the frame of reference, plays an important role in this connection. It has an effect on all scales inside the system with it.

The phase rate of the propagation function is equal to the reciprocal of PLANCK's smallest increment r_0. Even the other PLANCK-units are the base of the model being functions of space, time, distance and speed. A different definition of the PLANCK charge is used in the form $q_0 = \sqrt{\hbar/Z_0}$. At intervals of r_0 special vortices are collocated in the form of a cubic face-centred crystal lattice (fc). LANCZOS called them „MINKOWSKIan line elements, which are only approximately MINKOWSKIan“, here abbreviated as MLE. Thus it's rather about a physical object and not about that, the MINKOWSKIan line element is actually defined. I nominated the whole wave field as metric wave field (metrics).

I already set up a scheme in [1], with which most of the universal natural constants in the metric (SI)-system could be calculated, on the basis of only five fixedly defined values. But accuracy left a lot to be desired. As part of this work the properties of the electron are analyzed in detail with the result, that it's well suited as a scale basis of the metric system. Furthermore some weak points of latter one have been found, getting in the way of a further improvement of measuring accuracy.

It's mostly about fixed values used to the definition of base units, which in turn depend on other values as well as on time and on the reference frame. Since these dependencies were unknown so far, the arbitrary lock-up of specific values leads to unreckoned deviations during the verification of measurements of other labs, so far characterized as „inaccuracies of measurement“. Someone indeed supposed the deviations to be based on hitherto undiscovered particles or interactions. In the course of this work the SI-system itself is worried out to be the real cause. It's like a out-of-tune piano, I recognize the melody, but it sounds somehow crazy. In the end a consistent system is presented, which yields exact results and with which nearly all other natural „constants“ can be calculated by means of only five fixed values, the so called *subspace values*.

One distinctive feature of the model is, that the so called *subspace* – the space, the metric wave field propagates in – among μ_0 and ε_0, disposes of a third property, the specific conductivity κ_0 in the region of $1.37 \cdot 10^{93}\,\mathrm{Sm}^{-1}$. It also generates expansion. All four values and with it even c are „hard-wired“ and do not change at all. Whether and how it doesn't lead to contradictions with the propagation of „normal“ EM-waves, is not subject of the work on hand. According to the model they propagate as overlaid interferences of the metric wave field and not directly within *subspace*. Even all living processes take place within the metric wave field and not within *subspace*. See [6] for more detailed information.

2. Fundamentals and hypotheses

Before we get to the actual calculation, it's necessary, to define certain base items of the model, mostly without derivation. Read more about this in [6]. The PLANCK-units, as well as the base items of the theoretical electro-technics play a very special role in this connection. For this reason, as usual there, I'm using the letter j instead of i or ⅈ as usual in mathematics. In the first sections still the values of the universal natural constants calculated in [1] table 10 are used, based on the model evolved there using the $CODATA_{2014}$-values. For the gravity constant G the BRUKER-value has been used initially.

2.1. Definition of base items

At first the base items of the theoretical electro-technics. They apply independently from the model (1). Beneath (2) the most important PLANCK-units are shown. The introduction of the specific conductivity of the vacuum turns out to be the *missing link* among each other and even to other values.

$$c = \frac{1}{\sqrt{\mu_0\varepsilon_0}} \quad \Big| \quad Z_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}} = \sqrt{\frac{L_0}{C_0}} = \frac{\varphi_0}{q_0} = \frac{\mathbf{E}}{\mathbf{H}} \quad \Big| \quad L_0 = \mu_0 r_0 \quad C_0 = \varepsilon_0 r_0 \quad R_{0R} = 1/(\kappa_0 r_0) \ \text{Series resistor} \tag{1}$$

$$r_0 = \sqrt{\frac{G\hbar}{c^3}} = \sqrt{\frac{2t}{\mu_0\kappa_0}} \quad \Big| \quad m_0 = \sqrt{\frac{\hbar c}{G}} = \frac{\mu_0\kappa_0\varphi_0^2}{Z_0} \quad \Big| \quad \varphi_0 = \sqrt{\hbar Z_0} \quad q_0 = \sqrt{\hbar/Z_0} \tag{2}$$

One single line-element can be specified by the model of a lossy oscillating circuit with shunt resistor. One special property *of that model only* is, that the Q-factor of the circuit equals the phase angle $2\omega_0 t$ of the Bessel function. It applies $Q_0=2\omega_0 t$. The value ω_0 corresponds to the PLANCK-frequency in this connection.

$$\omega_0 = \sqrt{\frac{c^5}{G\hbar}} = \sqrt{\frac{\kappa_0}{2\varepsilon_0 t}} = \frac{1}{\sqrt{L_0 C_0}} = \frac{c}{r_0} \quad \Big| \quad t_0 = \frac{1}{2}\sqrt{\frac{G\hbar}{c^5}} = \sqrt{\frac{\varepsilon_0 t}{2\kappa_0}} \tag{3}$$

$$Q_0 = 2\omega_0 t = \kappa_0 r_0 Z_0 = \frac{\hbar R_0}{\varphi_0^2} = \frac{R_0}{Z_0} = \frac{c^2}{v^2} = \sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \tag{4}$$

$$H_0 = \frac{\dot{r}_0}{r_0} = \frac{1}{R_0 C_0} = \frac{\varepsilon_0}{\kappa_0}\frac{1}{L_0 C_0} = \frac{1}{\kappa_0\mu_0 r_0^2} = \frac{\varepsilon_0\omega_0^2}{\kappa_0} = \frac{1}{2T} = \frac{\omega_0}{Q_0} \tag{5}$$

The numeric value of Q_0 according to table 1 is about $7.5419\cdot10^{60}$ and depends on the real value of H_0. Except for the quantities of subspace μ_0, ε_0, κ_0 and c all other ones are functions of space, time and even of the velocity v with respect to the metric wave field. The reason is, that the spatiotemporal function of the metric wave field should emulate the relativistic effects and it really does. The GR-dependencies aren't considered here furthermore.

That makes the PLANCK units depend on the frame of reference, which is even defined by them. And all of them are bound by the phase angle Q_0. But the variations mostly cancel each other creating the impression, that the values are constant. Reference-frame-dependent values are marked with a swung dash e.g. $\tilde{Q}_0$ being constants by character. Still important are the values with a phase angle $Q_1=1$. They describe the conditions directly at the particle horizon. They are constants too, because they are defined only by quantities of subspace. Thus, they are mostly qualified for reference-frame-independent conversions of certain values, so-called couplings. One example is the conversion of the magnetic flux φ_1 to the magnetic field strength $H_1=\varphi_1/(\mu_0 r_1^2)$ as basis of a temporal function containing reference-frame-dependent elements (r_0). r_1 would be the so-called coupling-length then. Expression (8) shows the relations to the PLANCK-units and to the values of the universe as a whole.

$$r_1 = \frac{1}{\kappa_0 Z_0} \quad \Big| \quad M_1 = \mu_0\kappa_0\hbar \quad \Big| \quad t_1 = \frac{1}{2}\frac{\varepsilon_0}{\kappa_0} \quad \Big| \quad \omega_1 = \frac{\kappa_0}{\varepsilon_0} = \frac{1}{2t_1} \tag{6}$$

$$R = Q_0 r_0 = Q_0^2 r_1 \quad \Big| \quad M_1 = Q_0 m_0 \quad \Big| \quad T = Q_0 t_0 = Q_0^2 t_1 \quad \Big| \quad \omega_1 = Q_0\omega_0 = Q_0^2 H_0 \tag{7}$$

$$\varphi_1 = \sqrt{\hbar_1 Z_0} \quad \Big| \quad q_1 = \sqrt{\hbar_1/Z_0} \quad \Big| \quad \hbar_1 = \hbar Q_0 \quad \Big| \quad \kappa_0 = \frac{c^3}{\mu_0 G\hbar H_0} \tag{8}$$

The action quantum $\hbar_1$ and $\hat{\hbar}_1$ is not a quantity of subspace, but the initial action, our universe „got“ in the early beginning. That value is the only one „set-screw“, with which „one“ could exert influence on the future appearance of the universe. All other values are „hard-wired“ with Q_0 depending on space and time. There is no „fine-tuning“ either. With expression (2) right-hand and (8) it’s about an effective value, i.e. $\hbar$, φ_0 and q_0 are temporal functions too. For section 3.3. still the definition of NEWTON‘s gravitational constant:

$$G = \frac{c^3}{\mu_0\kappa_0\hbar H} = \frac{2c^3 t}{\mu_0\kappa_0\hbar} = c^2\frac{R}{M_1} = c^2\frac{r_0}{m_0} \tag{868 [6]}$$

2.2. Temporal function

We get the exact temporal function for the magnetic flux φ_0 by solving the differential equation (9). It is based on a lossy oscillating circuit *with expansion*, i.e. the single components R_0, L_0 and C_0 are changing with increasing r_0. Expression (9) mainly differs from a normal oscillating circuit without expansion, with harmonic solution by the factor before $\dot{\varphi}_0$, 1 with expansion, ½ without.

$$\ddot{\varphi}_0 t + \dot{\varphi}_0 + \frac{1}{2}\frac{\kappa_0}{\varepsilon_0}\varphi_0 = 0 \tag{9}$$

In contrast to the expression without expansion there is no drop-down in the resonance frequency ω_0 with (9), normally caused by the influence of the loss-resistance R_0. But we obtain another as solution:

$$y = a_0\,{}_0F_1(;1;-Bx) \qquad \text{with} \quad a_0 = \hat{\varphi}_1/2 \quad B = \frac{1}{2}\frac{\kappa_0}{\varepsilon_0} \quad x = t \tag{10}$$

According to [4] applies

$${}_0F_1(;b;x) = \Gamma(b)(jx)^{b-1} J_{b-1}(j2x^{\frac{1}{2}}) \qquad \text{Hypergeometric function } {}_0F_1 \tag{11}$$

J_n is the Bessel function of n^{th} order, thus

$${}_0F_1(;1;-Bx) = \Gamma(1)(jBx)^0 J_0(\sqrt{4Bx}) \tag{12}$$

$$y = a_0 J_0(\sqrt{4Bx}) \tag{13}$$

$$\varphi_0 = a_0 J_0\left(\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}}\right) = a_0 J_0(Q_0) \tag{14}$$

Since it’s about a differential equation of 2^{nd} order and the grade of the Bessel function is integer, the general solution is:

$$\varphi_0 = \hat{\varphi}_i(c_1 J_0(2\omega_0 t) + c_2 Y_0(2\omega_0 t)) \tag{15}$$

The factors c_1 and c_2 may be imaginary or complex even here. According to [5] it's more favourable, if we consider both Hankel functions:

$$H_0^{(1)}(x) = J_0(x) + Y_0(x) \quad \text{and} \tag{16}$$

$$H_0^{(2)}(x) = J_0(x) - Y_0(x) \tag{17}$$

as linearly independent solutions composing the general solution

$$y(x) = c_1 H_0^{(1)}(x) + c_2 H_0^{(2)}(x) \tag{18}$$

with it. Then, the general solution (15) reads then:

$$\varphi_0 = \hat{\varphi}_i(H_0^{(1)}(2\omega_0 t) + H_0^{(2)}(2\omega_0 t)) \tag{19}$$

For our further examinations, we set c_1 and c_2 in (18) equal to 1 for the moment. Then we get as specific solution (20) and for approximation, envelope curve and effective value:

$$\varphi_0 = \hat{\varphi}_i J_0(2\omega_0 t) = \hat{\varphi}_i \operatorname{Re}(H_0^{(1)}(2\omega_0 t)) \qquad \varphi_0 = \hat{\varphi}_i J_0\left(\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}}\right) \tag{20}$$

$$\varphi_0 = \sqrt{\frac{2}{\pi}} \frac{1}{\sqrt{2\omega_0 t}} \cos\left(2\omega_0 t - \frac{\pi}{4}\right) \qquad \text{Approximation} \tag{21}$$

$$\hat{\varphi}_0 = \sqrt{\frac{2}{\pi}} \frac{\hat{\varphi}_i}{\sqrt{2\omega_0 t}} \qquad \text{Envelope curve} \tag{22}$$

$$\varphi_0 = \frac{\varphi_i}{\sqrt{2\omega_0 t}} \qquad \varphi_0 \sim q_0 \sim Q_0^{-\frac{1}{2}} \;\Big|\; \hbar = \varphi_0 q_0 \sim Q_0^{-1} \qquad \text{Effective value} \tag{23}$$

The exact course of φ_0 (20), as well as of the approximate function of the envelope curve (22) and of the effective value (23) is shown in Figure 1. Also depicted are the original Bessel functions, which you can't see however, because they are completely covered by the approximation.

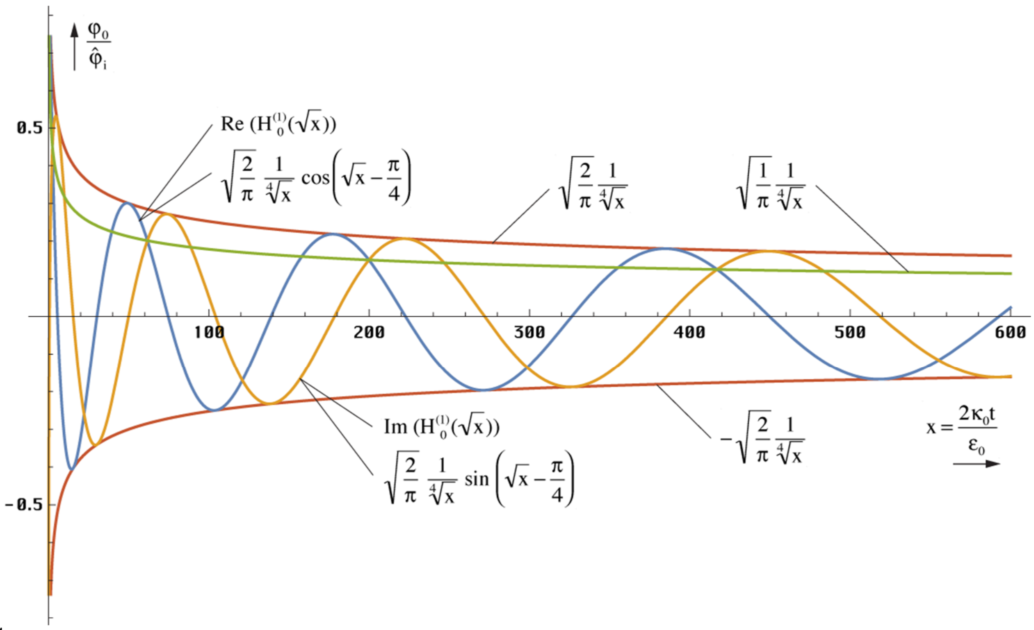

Figure 1
Course of magnetic flux as well as of approximation- and envelope-functions across a greater time period

Thus, with greater arguments, no differences are statable, neither in the amplitude, nor in the phase. Most important for the quality of the approximation is the course in the striking distance of t=0. It is shown in Figure 2 and it turns out to be very good until the particle horizon at $Q_0=1$. All data so far are summarized. See [1] for details and the exact derivation.

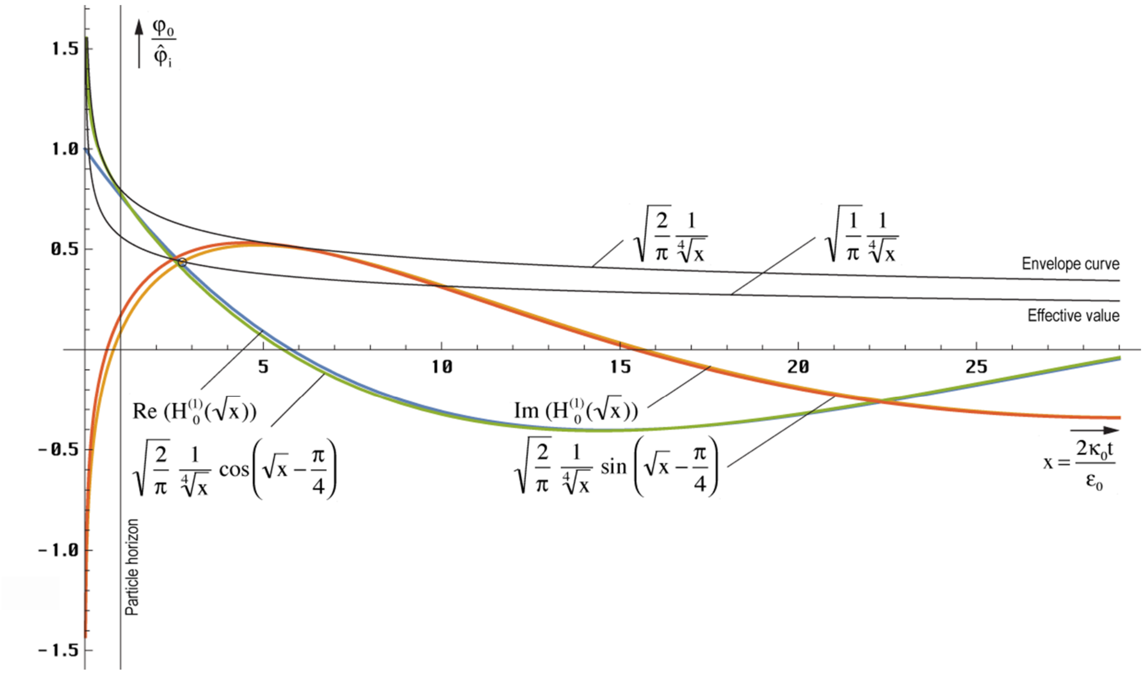

Figure 2
Course of flux as well as of the approximate- and envelope-functions nearby the singularity

2.3. Propagation function

2.3.1. Exact solution

For further contemplations we need the propagation function of the metric wave field in any case, as well as the values connected with it. You can read from section 3 on if you are already familiar with the model.

2.3.1.1. Temporal function

In contrast to MAXWELL, which used the first term of the harmonic solution (108 [1]) $e^{j\omega t}$ as ansatz, we now choose the first term of expression (19), obtained as an independent solution of the differential equation (9). It's about the temporal function of the magnetic flux φ_0 there, relating to one single MLE, from which the charge q_0 can be derived. For the propagation function however we need the magnetic and electric field strength **H** and **E**. The relation:

$$\varphi = \int_A \mathbf{B}\,dA \qquad \text{with } \mathbf{B}=\mu_0\mathbf{H} \qquad \text{leads to} \qquad |\mathbf{H}| = \frac{\hat{\varphi}_0}{\mu_0 r_0^2} \tag{24}$$

Because of r_0 indeed the right-hand expression depends on the frame of reference. Moreover we are rather looking for the starting value at T=0. The temporal function is just known. Hence, we must carry out a reference-frame-independent coupling only. The coupling-length r_k is not arbitrary in this case. Because the imaginary part of the Hankel function is coming from infinity, the starting value φ_0 is defined at the point $2\omega_0 t=Q_0=1$. The coupling-length at this point is r_1 as already predicted more above. This value is denominated as $\mathbf{H_1}$ resp. $\mathbf{E_1}$. With respect to the fact, that (23) is an effective value, we obtain the following relations:

$$\mathbf{E_1} = \frac{q_1}{\varepsilon_0 r_1^2}\sqrt{2} = \frac{1}{Z_0}\frac{\varphi_0}{\varepsilon_0 r_0^2}\sqrt{2} \qquad \mathbf{H_1} = \frac{\varphi_0}{\mu_0 r_0^2}\sqrt{2} \tag{25}$$

$$\underline{\mathbf{E}} = \mathbf{E_1}\, H_0^{(1)}(2\omega_0 t) \qquad \underline{\mathbf{H}} = \mathbf{H_1}\, H_0^{(1)}(2\omega_0 t) \tag{26}$$

Here again, the real part of the vector corresponds to an orientation in y-, the imaginary one in z-direction, x is the propagation direction. As already stated, there is an analogy between the exponential function $e^{j2\omega t}$ and the Hankel function. Both are transcendent complex functions and periodic respectively almost periodic. Of course, there is also a solution of the MAXWELL equations for (26). The detailed derivation can be read in [6] once again. Important is the complex wave propagation velocity $\underline{c}$ and the field wave impedance $\underline{Z}_F$:

$$\underline{c} = \frac{c}{j\omega_0 t}\frac{1}{\sqrt{1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2}} \qquad \text{with} \qquad \Theta = \frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)} \tag{27}$$

$$\underline{c} = \frac{c}{j\omega_0 t}\frac{1}{\sqrt{1-\Theta^2}} \qquad \underline{Z}_F = \frac{Z_0}{j\omega_0 t}\frac{1}{\sqrt{1-\Theta^2}} \tag{28}$$

We see that the propagation-velocity converges to zero for large t. The same is applied to the field-wave impedance too. We have to do it with a quasi-stationary wave-field (standing wave) filling very well the requests on a metrics. The propagation-velocity is complex again. A decomposition into real- and imaginary-part works out quite difficult, but it's mathematically possible however. The solution for $\underline{c}$ reads:

$$A = \frac{J_0(Q_0)J_2(Q_0)+Y_0(Q_0)Y_2(Q_0)}{J_0^2(Q_0)+Y_0^2(Q_0)} \qquad \rho_0 = \frac{1}{2}\sqrt[4]{(1-A^2+B^2)^2+(2AB)^2}\ ^{1}$$

$$B = \frac{J_2(Q_0)Y_0(Q_0)-J_0(Q_0)Y_2(Q_0)}{J_0^2(Q_0)+Y_0^2(Q_0)} \qquad \rho_0 = \frac{1}{2}\left|\sqrt{1-\Theta^2}\right| \qquad \theta = \frac{2AB}{1-A^2+B^2} \tag{29}$$

$$\frac{1}{\rho_0 Q_0} = \frac{c_M}{c} = \frac{1}{Q_0}\left|\frac{2}{\sqrt{1-\Theta^2}}\right|$$

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RhoQ = 2/#/Abs[Sqrt[1 - (HankelH1[2, #]/HankelH1[0, #])^2]] &
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$$\phi_0 = \frac{1}{2}\arctan\theta = \arg\left[\frac{1}{\sqrt{1-\Theta^2}}\right] - \frac{\pi}{2} \tag{30}$$

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PhiQ = Arg[1/Sqrt[1 - (HankelH1[2, #]/HankelH1[0, #])^2]] -π/2 &
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The factor ½ arises from the 4^{th} root. Expression (27) may be split into a real- and an imaginary part (31). A starts at $+\infty$ converging to -1. The course resembles the function $1/A^2-1$ approximately, which cannot be used well as approximation however. B has a course like $1/B^2$ and is converging to zero. The same is applied to θ then. The bracketed expression converges to one with it. For $Q_0 \geq 5$ the approximation $\rho_0^2 Q_0^2 \approx Q_0$ applies with $\Delta \leq 1\%$.

$$\underline{c} = \frac{c}{\rho_0 Q_0}\left(\cos\frac{1}{2}\arctan\theta + j\sin\frac{1}{2}\arctan\theta\right) = \frac{c}{\rho_0 Q_0}e^{j\frac{1}{2}\arctan\theta} = \frac{c}{\rho_0 Q_0}e^{j\phi_0} \tag{31}$$

Unfortunately (31) cannot be transformed into an expression similar to (179 [6]) with area-functions, so that the ambiguity of the arctan-function leads to a partially wrong result. Thus we should better calculate with the following substitution:

[1] Due to the inaccuracy of the modulus of the Hankel function for derivatives >0, the results of the AB-expressions of (29) slightly differ from the (30) ones which are more exact. Thus, the calculation of all values and graphics is switched over to (30) from this edition on.

$$\arctan\theta = \arg\left(\left(1 - A^2 + B^2\right) + j2AB\right) \qquad \arg\underline{c} = \frac{1}{2}\operatorname{arccot}\theta - \frac{\pi}{4} \qquad (32)$$

While the real part of $\underline{c}$ is defined as the velocity in propagation direction, the imaginary part can be interpreted as a velocity rectangular thereto. The appearance of an imaginary part in $\underline{c}$ means also that there is an attenuation anywhere (refer to Figure 4). A numerical handling of (27) even can be processed with »Mathematica« resulting in the course figured in Figure 3. Since the Hankel functions, with larger arguments, can be expressed well by other analytic functions, we will try to declare approximative solutions later.

We have to do with a case of inversion here. This manifests by the fact that the propagation-velocity first ascends from zero to an amount of 0.851661c (at 0.748729 t_1) and then descends again asymptotically to zero.

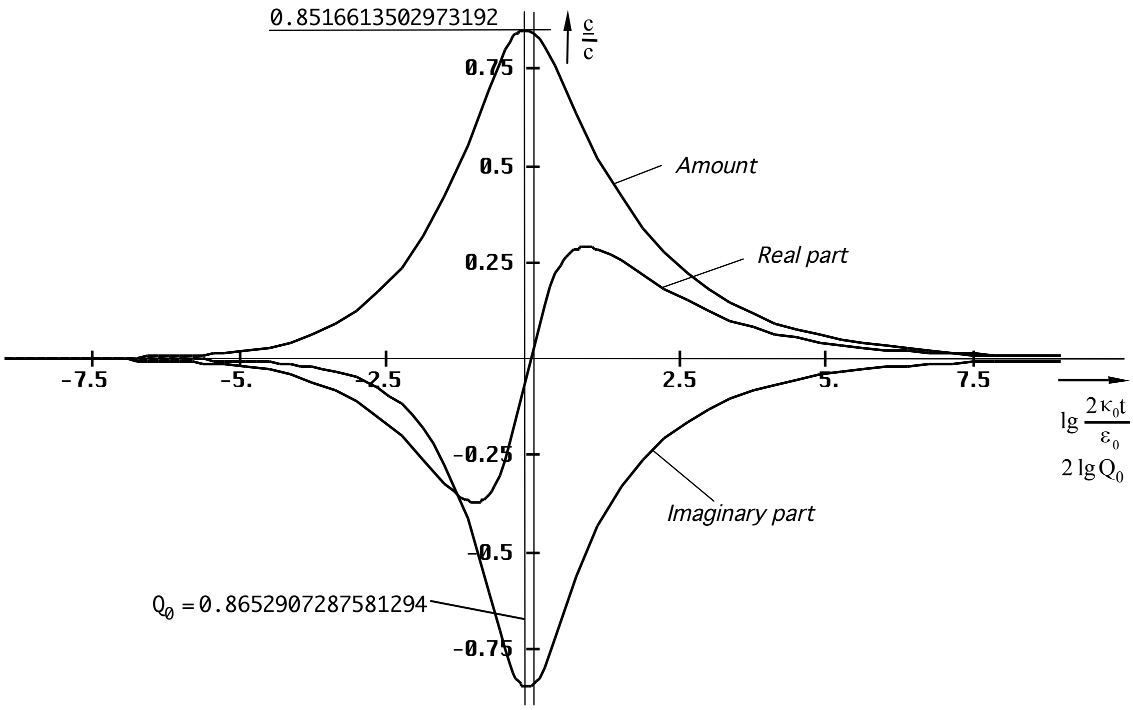

Figure 3
Propagation-velocity
in dependence on time (logarithmic time-scale)

With it, the world-radius (wave-front) of this model doesn't expand with c but with 0.851661c only, which figures no violation of the SRT anyway. However, a contradiction arises to the usual definition R=cT, which has been solved (see section 3.4. or [7]).

2.3.1.2. Propagation rate

To specify the propagation-function we need both, the temporal function and the propagation rate $\underline{\gamma}=\alpha+j\beta$. The normal form of the propagation function is given by:

$$\underline{\mathbf{E}} = \mathbf{E}\, e^{j\omega\left(t-\frac{x}{\underline{c}}\right)} = \mathbf{E}\, e^{j\omega t-\underline{\gamma}x} = \mathbf{E}\, e^{j(\omega t+j\underline{\gamma}x)} \qquad (33)$$

Contrary to (33) the argument in the case with expansion is real. Strictly speaking, namely it's not the Hankel function but the modified Hankel function $Z_0^{(2)} = I_0(z)-jK_0(z)$ being the equivalent of the exponential-function. It is valid for $I_0(z)=J_0(jz)$ however only for pure imaginary arguments. With complex arguments, the real part cannot be drawn to a position ahead of the Hankel-function as usual with the exponential-function, since the power rules aren't applied to Hankel functions anyway. It's possible first with larger arguments z. In general the modified Hankel function isn't used however. Therefore, we use for the base the „ordinary" Hankel function adapting the propagation-function accordingly. To avoid contradictions with the classic definition of propagation rate – real-part equals attenuation rate, imaginary-part equals phase-rate – the propagation-function should read as follows then (analogously for $\underline{\mathbf{H}}$):

$$\underline{\mathbf{E}} = \mathbf{E}\, H_0^{(1)}\left(2\omega_0\left(t - \frac{x}{\underline{c}}\right)\right) = \mathbf{E}\, H_0^{(1)}(2\omega_0 t - j\underline{\gamma} x) \tag{34}$$

This is not quite the classic expression for a propagation-function. Attention should be paid to the factor 2 which can be assigned both to the frequency, as well as the time-constant. With the definition of propagation rate $\underline{\gamma} = \alpha + j\beta$ it obviously belongs to the frequency since $\underline{\gamma}$ depends on phase velocity dx/dt, but not on the half of dx/(2dt). By equating both arguments of (34) one gets then:

$$\underline{\gamma} = -\frac{2\omega_0}{\underline{c}} = j\kappa_0 Z_0 \sqrt{1-\Theta^2} \tag{35}$$

From (31) the reciprocal of $\underline{c}$ can be determined very easily. Then we get for $\underline{\gamma}$:

$$\frac{1}{\underline{c}} = -\frac{\omega_0 t \rho_0}{c}\left(\cos\frac{1}{2}\arctan\theta - j\sin\frac{1}{2}\arctan\theta\right) \tag{36}$$

$$\underline{\gamma} = \alpha + j\beta = -2\omega_0/\underline{c} = \frac{2\omega_0^2 t \rho_0}{c}\left(\cos\frac{1}{2}\arctan\theta - j\sin\frac{1}{2}\arctan\theta\right) \tag{37}$$

$$\underline{\gamma} = \rho_0 \kappa_0 Z_0\left(\cos\frac{1}{2}\arctan\theta - j\sin\frac{1}{2}\arctan\theta\right) \tag{38}$$

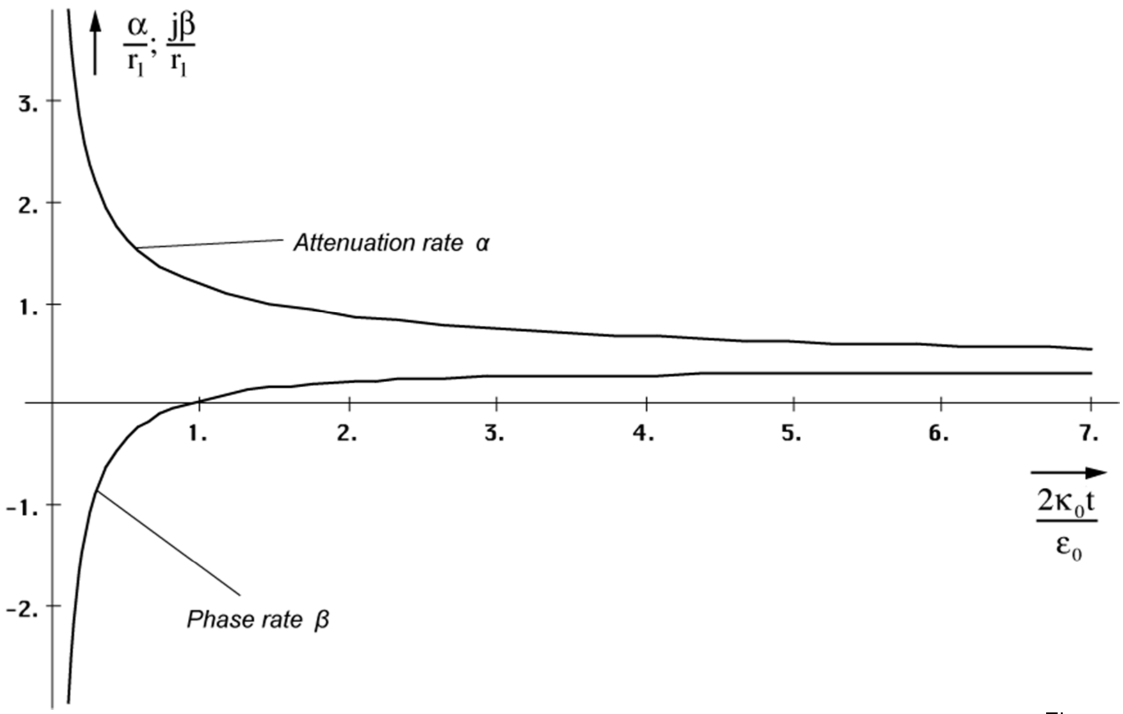

Figure 4
Phase-rate and attenuation rate
in dependence on time (linear scale)

With accurate contemplation one recognizes that α and β, evaluated by its action, are exchanged in fact (α = phase-rate, β = attenuation rate). This is caused thereby that a rotation of about 90° (j) occurs during propagation (Figure 7). x turns into y and y into –x. The attenuation α, starting at the point of time t=0, starting off infinity, is decreasing exponentially. To the present point of time, one can say that there is basically no attenuation anyway. This doesn't apply however considering cosmologic time periods.

At the point of time $0.897\,t_1$ (Q = 0.947), the function β has a zero-passage. This supplies the somewhat particular course in logarithmic presentation (Figure 5). It's about a phase-jump of 180° in this case. From the point of time 100 t_1 on we are able to declare, referring to Figure 4, the following approximation:

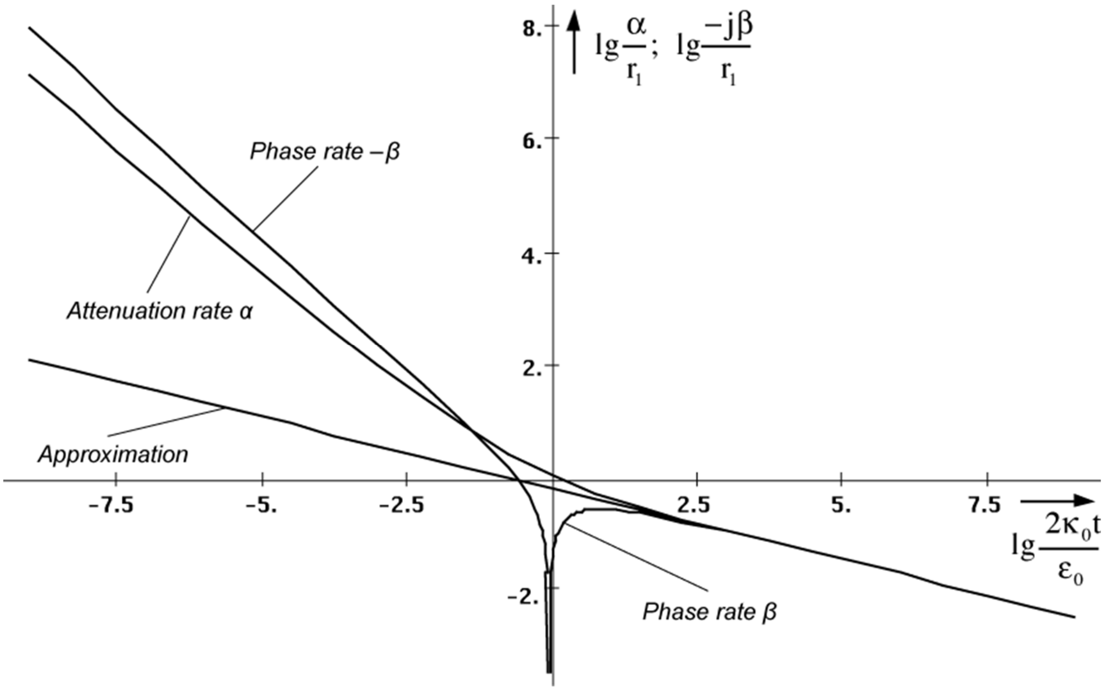

Figure 5
Phase rate and attenuation rate
in dependence on time (logarithmic)

$$\underline{\gamma} \approx (1+j)\kappa_0 Z_0 \sqrt[4]{\frac{\varepsilon_0}{2\kappa_0 t}} \qquad\qquad \underline{\gamma} \approx (1+j)\frac{\kappa_0 Z_0}{\sqrt{2\omega_0 t}} \tag{39}$$

These relationships can be derived as well graphically from Figure 4, as explicitly using (35) by application of (42). However, it's necessary to multiply (35) with j, in order to take account of the 90° turning (Figure 7). Then, to the approximation $\underline{\gamma}=2\omega_0/\underline{c}$ is applied. Phase rate and attenuation rate are the same from 100 t_1 on approximately. This is the behaviour of an ideal conductor.

2.3.2. Asymptotic approximation

In [23] an asymptotic formula for the Hankel function is declared. It reads:

$$H_\nu^{(1)}(z)=\sqrt{\frac{2}{\pi z}}\,e^{j\left(z-\frac{\pi}{2}\nu-\frac{\pi}{4}\right)}\left[1+O\left(z^{-1}\right)\right] \qquad \text{for } 0<z<\infty \tag{40}$$

Put into (27), one sees that nearly all expressions can be reduced. The root-expression R converges to a value of:

$$R=\sqrt{1-\left[1+O_2(t^{-1/2})-O_0(t^{-1/2})\right]^2} \quad\approx\quad \sqrt{2O_2(t^{-1/2})-2O_0(t^{-1/2})} \tag{41}$$

The root-expression result just only depends on the remainder terms which is tending to zero as well. Therefore, this base is not suitable for our purposes.

For $\underline{\gamma}$, we have already found an approximation, still remain $\underline{c}$ and $\underline{Z}_F$. In Figure 3 we already depicted the course of $\underline{c}$. To the graphic determination of an approximation however, we require the double logarithmic representation (Figure 6). To be considered, is the fact that the imaginary part is actually negative.

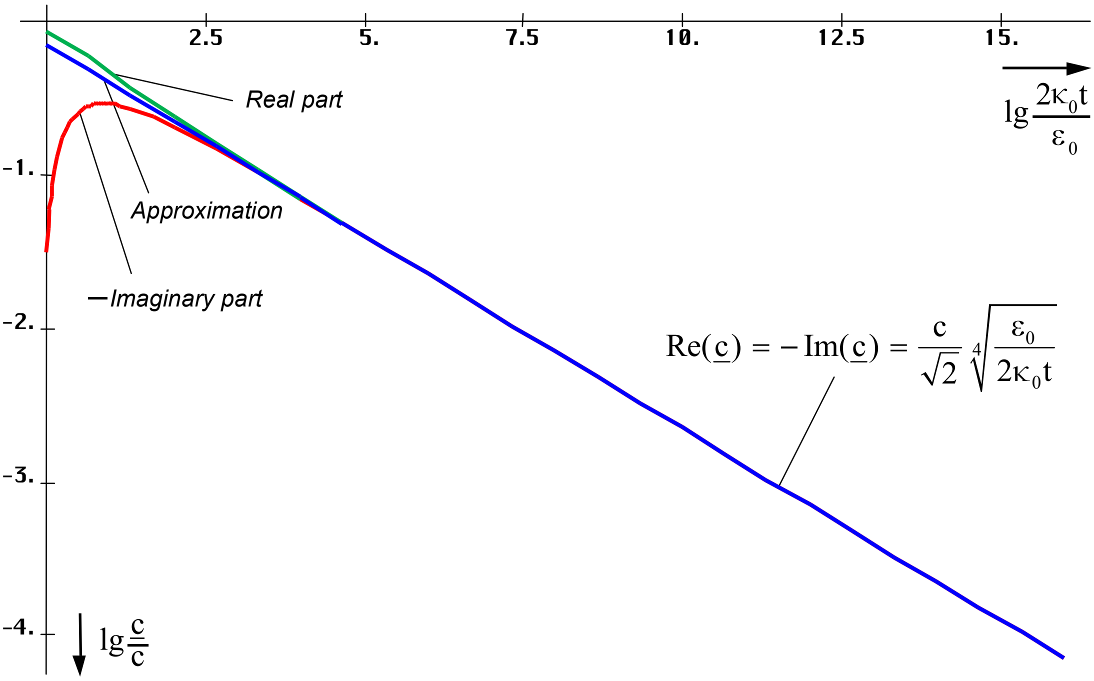

Figure 6
Propagation-velocity
in dependence on time (double logarithmic)

$$\underline{c} = \frac{1-j}{\sqrt{2}}\, c \sqrt[4]{\frac{\varepsilon_0}{2\kappa_0 t}} \qquad \underline{c} = \frac{1-j}{2} \frac{c}{\sqrt{\omega_0 t}} \tag{42}$$

$$|\underline{c}| = c \sqrt[4]{\frac{\varepsilon_0}{2\kappa_0 t}} \qquad |\underline{c}| = \frac{c}{\sqrt{2\omega_0 t}} \quad (1.03807 \cdot 10^{-22}\ \mathrm{ms}^{-1}) \tag{43}$$

$$\underline{Z}_F = \frac{1-j}{\sqrt{2}}\, Z_0 \sqrt[4]{\frac{\varepsilon_0}{2\kappa_0 t}} \qquad \underline{Z}_F = \frac{1-j}{2} \frac{Z_0}{\sqrt{\omega_0 t}} \tag{44}$$

2.3.3. Expansion curve

At the world-radius, the universe expands with the maximum velocity of 0.851661c, in the inside with a velocity decreasing more and more. Since the wave count in the interior of a sphere with defined radius r(c,t) is decreasing, the deficit is balanced by an increase of wavelength. Outside the wave count ascends continuously due to propagation.

For greater t the expansion of the wave front proceeds nearly rectilinear with an angle of −45° proportionally $t^{3/4}$. But the behaviour looks somewhat different near the singularity. In The track-course of a single sector of wave front near the singularity is shown in Figure 7. We see a kind of parabola, with greater t a hyperbola. And there is a rotation in propagation direction about an angle of 90°.

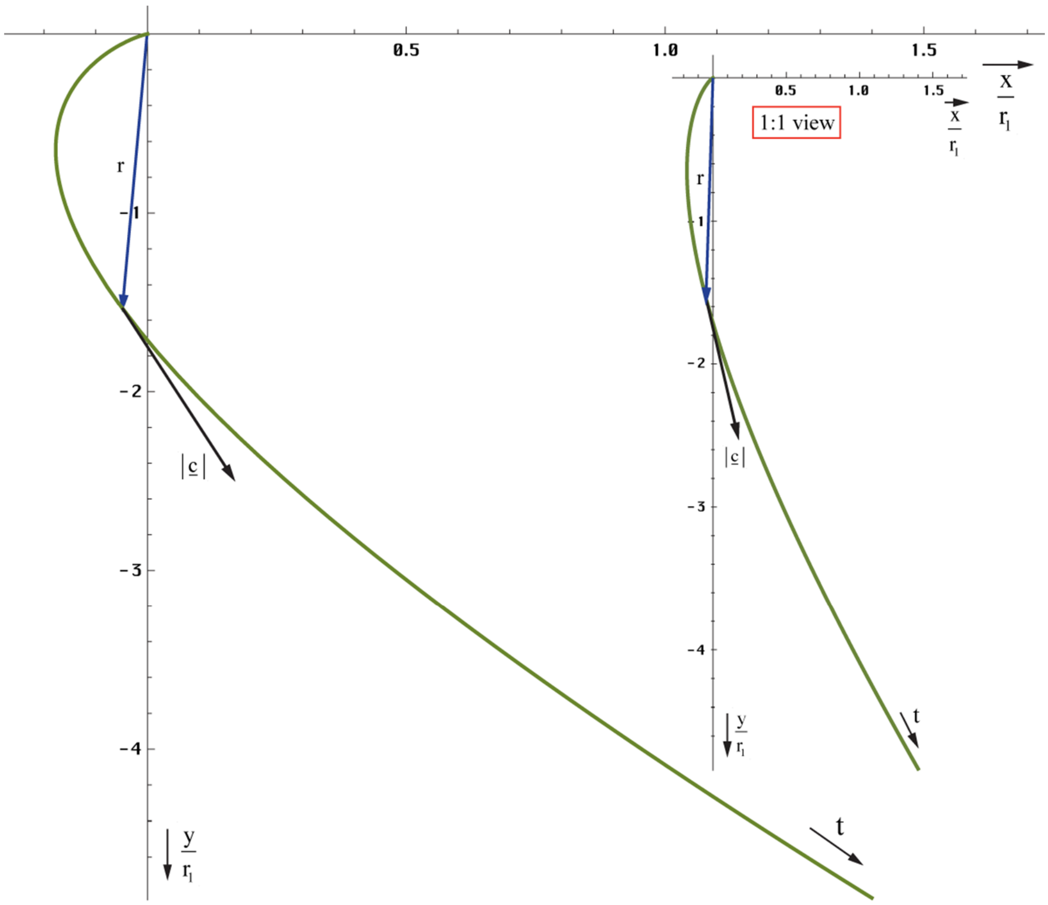

Figure 7
Track-curve near the singularity
in dependence on time

2.3.4. Approximative solution

Now we want to set-up an approximation for the propagation function. The normal form is $\mathbf{E}=\hat{\mathbf{E}}\,e^{j\omega t-\underline{\gamma}x}$ with $\underline{\gamma}=\alpha+j\beta$. But with the exact solution (39) there is a case on hand, with which α and β contain both damping- and phase-information and the wave function isn't harmonic either. That way we aren't able to form a reasonable propagation function at all.

In the case $t \gg t_l$ phase- and attenuation rate are of the same size. Thus, the model behaves similar to a metal. There α does not stand for a damping, but for a rotation, namely as long as, with vertical incidence, a value of π is reached so that the wave exits the metal in the opposite direction after a minimal intrusion. The depth of penetration depends on the material properties, the wave length and the angle of incidence. In case of this model the material properties aren't constant either, $\underline{\gamma}$ decreases with t and x. Hence it suffices to a rotation of 90° only and the wave remains in the medium (vacuum). In any case, there is a rotation too.

To cope with it, we do a rotation of the coordinate system about $\pi/4$. That corresponds to a Multiplication with $\sqrt{j}$ and we get a purely imaginary solution. So becomes $\alpha=0$ and $\underline{\gamma}=j\beta$ and the exponentially related attenuation vanishes. Indeed, we still have to multiply the result with $\sqrt{2}$ and to replace x by r. Despite $\alpha=0$ the amplitudes of **E** and **H** are decreasing continuously. That's caused by the Hankel function alone, resp. by the radical expression in (45). With it amplitude and phase are firmly interlinked (minimum phase system). Now the rotation angle in space is equal to $\theta+\pi/4$. But a separation of phase- and damping-information isn't possible yet. But we can work with very high precision using the approximation equations in this case. To the general Hankel function $H_0^{(1)}(\omega t-\beta x)$ the following approximation applies (analogously for **H**):

$$\underline{\mathbf{E}} = \hat{\mathbf{E}}\, H_0^{(1)}(\omega t - \beta x) \approx \hat{\mathbf{E}} \sqrt{\frac{2}{\pi(\omega t - \beta x)}}\; e^{j(\omega t - \frac{\pi}{4} - \beta x)} \tag{45}$$

Instead of $\underline{\gamma}x$ only the product βx with the phase rate appears in the exponent, since the amplitude rate is already emulated by the radical expression. With $t \gg 0$ the angle $\pi/4$ can be omitted. After rotation and transition $x \to r$ and $\omega \to 2\omega_0$ turns out:

$$\underline{\mathbf{E}} = \hat{\mathbf{E}}\, H_0^{(1)}(2\omega_0 t - 2\beta_0 r) \approx \frac{2\,\mathbf{E}_1}{\sqrt{2\omega_0 t - 2\beta_0 r}}\; e^{j(2\omega_0 t - \frac{\pi}{4} - 2\beta_0 r)} \qquad H_1 = \frac{\varphi_1}{\mu_0 r_1^2} \quad E_1 = \frac{q_1}{\varepsilon_0 r_1^2} = \frac{1}{Z_0}\frac{\varphi_1}{\varepsilon_0 r_1^2} \tag{46}$$

$\mathbf{E}_1$ is the peak value of $\mathbf{E}$ with $Q_0=1$. Indeed are both $\omega=2\omega_0$ and $\beta=2\beta_0$ (with double frequency even the phase rate must be doubled) no constants at all. That means, they depend on t and r at the same time, limiting the manageability of the approximation very much. You can see that also with the phase velocity v_{ph}. It is defined in the following manner:

$$v_{ph} = \frac{2\omega_0}{\beta} = \frac{2c}{\sqrt{2\omega_0 t}} = 2|\underline{c}| \qquad \text{for } t \gg 0 \tag{47}$$

Thus, the phase velocity is equal to the double absolute value of propagation velocity. That's caused by the factor 2, since phasing with double frequency propagates with double velocity too. For interest, also the group velocity should be stated here:

$$v_{gr} = \frac{1}{d\beta/d\omega_0} = -2|\underline{c}| \qquad \text{for } t \gg 0 \tag{48}$$

Except for the algebraic sign both results are equal. That means, the propagation takes place free from any bias. Further to the approximation. With (22) in section 2.2. we had already found a very good approximation, almost exact, for the same temporal function.

$$\underline{\mathbf{E}} \approx \hat{\mathbf{E}} \sqrt{\frac{2}{\pi}}\, \frac{e^{j(2\omega_0 t + 2\beta_0 x)}}{\sqrt{2\omega_0 t + 2\beta_0 x}} = 2\,\mathbf{E}_1 \frac{e^{j2(\omega_0 t + \beta_0 r)}}{\sqrt{2\omega_0 t + 2\beta_0 r}} \qquad \text{with} \quad \beta_0 = \frac{\kappa_0 Z_0}{\sqrt{2\omega_0 t}} \tag{49}$$

Now, expression (49) enables to define an equivalent-$\alpha=\alpha_0$ and, with it, even an equivalent-$\underline{\gamma}_0=\alpha_0+j2\beta_0$, in order to get it up to the normal form for propagation functions.

$$\underline{\mathbf{E}} \approx 2\,\mathbf{E}_1\, e^{j2\omega_0 t - \underline{\gamma}_0 r} \qquad \text{with} \quad \underline{\gamma}_0 = \frac{1}{2r} \ln\left(2\omega_0 t + \frac{2\kappa_0 Z_0}{\sqrt{2\omega_0 t}} r\right) + j\frac{2\kappa_0 Z_0}{\sqrt{2\omega_0 t}} \tag{50}$$

That's already a big step forward. Unfortunately, both ω_0 and $\underline{\gamma}_0$ depend on time. It's not critical for $2\omega_0 t$, because it's multiplied by t anyway. Else with $\underline{\gamma}_0$, it should depend on r only. To the substitution of t in (49ff) we firstly put (43) left-hand into $t=r/|\underline{c}|$. The real propagation velocity becomes effective here and not v_{ph} or v_{gr}. Then we rearrange after t. Putting into (49) right-hand we get:

$$t = \frac{r}{c} \sqrt[4]{\frac{2\kappa_0 t}{\varepsilon_0}} \qquad t^{\cancel{4}3} = \frac{r^4}{c^4} \frac{2\kappa_0 \cancel{t}}{\varepsilon_0} = 2r^4 \mu_0^2 \varepsilon_0 \kappa_0 \tag{51}$$

$$\beta_0^{12} = \frac{1}{8} \kappa_0^{\cancel{12}8} Z_0^{\cancel{12}8} \frac{\cancel{\varepsilon_0^3}}{\cancel{\kappa_0^3}} \cdot \frac{1}{2r^4 \cancel{\mu_0^2}\, \cancel{\varepsilon_0}\, \cancel{\kappa_0}} = \frac{\kappa_0^8 Z_0^8}{2^4 r^4} \qquad \Bigg| \qquad \beta_0 = \sqrt[3]{\frac{1}{2r r_1^2}} \tag{52}$$

With it, we obtain for $\underline{\gamma}_0$ and the product $\underline{\gamma}_0 r$ the following expressions:

$$\underline{\gamma}_0 = \frac{1}{2r}\ln\left(2\omega_0 t + \left(\frac{2r}{r_1}\right)^{\frac{2}{3}}\right) + j\left(\frac{2}{r r_1^2}\right)^{\frac{1}{3}} \qquad \text{for } t \gg 0 \tag{53}$$

$$\underline{\gamma}_0 r = \frac{1}{2}\ln\left(2\omega_0 t + \left(\frac{2r}{r_1}\right)^{\frac{2}{3}}\right) + j\left(\frac{2r}{r_1}\right)^{\frac{2}{3}} \qquad \text{for } t \gg 0 \tag{54}$$

Last but not least we can eliminate the time t completely. The value $\underline{\gamma}_0$ is proportional to $r^{-1/3}$ and, even more important, the product $\underline{\gamma}_0 r$ is proportional to $r^{2/3}$. Unfortunately, as already said, we can explicitly state $\underline{\gamma}_0(r)$ by approximation only. With the exact function (38) a separation, especially from t is impossible. But generally speaking, an exact solution is not required at all, since the approximation yields very good results until a striking distance to the particle horizon at $Q_0=1$, see Figure 2. Therefore, we will not follow up that matter at this point.

All hitherto stated approximations are based on the 4D-expansion-centre $\{r_1,r_1,r_1,t_1\}$. But it‘s more practicable to find a function, related to another centre. Most suitable seems to be the point, where we are, the „point being“. At first we substitute the time according to $t \to \tilde{T}+t$. The swung dash stands for the initial value at the point t=0 (nowadays) describing an inertial system. Hence it's about a constant. Because of $\tilde{T}=t_1\tilde{Q}_0^2$ we are able to factor out $\tilde{Q}_0$. The direction of time doesn't change. To the temporal part applies:

$$2\omega_0 t = \tilde{Q}_0\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} \tag{55}$$

For the spatial part β_0 we build up the inertial system once again using the substitution $r_1 \to \tilde{R}$. Because of $\tilde{R}=r_1\tilde{Q}_0^2$, as well as $\tilde{r}\,\tilde{Q}_0=-r$, now we are measuring from the other end, we can write for $2\beta_0$:

Exactly →

$$2\beta_0 = \tilde{Q}_0\left|\frac{2}{\tilde{r}\tilde{Q}_0\,\tilde{r}_1^2\tilde{Q}_0^2}\right|^{\frac{1}{3}} = -\tilde{Q}_0\left|\frac{2}{r\tilde{R}^2}\right|^{\frac{1}{3}} \qquad 2\beta_0 r = -\tilde{Q}_0\left|\frac{2r-\tilde{r}_0}{\tilde{R}}\right|^{\frac{2}{3}} = -\tilde{Q}_0\left|\frac{2r}{\tilde{R}}-\frac{1}{\tilde{Q}_0}\right|^{\frac{2}{3}} \tag{56}$$

Actually I should have to write $\tilde{r}$ instead of r. But because it's the argument of the function the tilde has been omitted. The right-hand expression considers the fact, that r_0 as smallest increment never can be underrun. The value α_0 is definitely determined by the envelope curve of the Hankel function, else it would be equal to zero. With it, we obtain for $\underline{\gamma}_0$ and the product $\underline{\gamma}_0 r$:

$$\underline{\gamma}_0 = \frac{1}{2r}\ln\tilde{Q}_0\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) + j\tilde{Q}_0\left(\frac{2}{r\tilde{R}^2}\right)^{\frac{1}{3}} \tag{57}$$

$$\underline{\gamma}_0 r = \frac{1}{2}\ln\tilde{Q}_0\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) + j\tilde{Q}_0\left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}} \tag{58}$$

With r_0 we have already found one elementary length. But LANCZOS speaks about another one [2]. That's the wave length of the metric wave field $\lambda_0=2\pi/\beta$. The approximation of λ_0 must be divided by 2 once again, due to the double phase velocity. Hence $\lambda_0=2\pi/\beta_0$ applies. To the comparison the expression for r_0 once again:

$$\lambda_0 = \frac{2\pi}{\rho_0(2\omega_0 t)\kappa_0 Z_0}\operatorname{cosec}\frac{1}{2}\arctan\theta(2\omega_0 t) \tag{59}$$

$$\lambda_0 = \frac{\pi}{\kappa_0 Z_0}\sqrt[4]{\frac{2\kappa_0 t}{\varepsilon_0}} = \frac{\pi}{\kappa_0 Z_0}\sqrt{2\omega_0 t} \qquad \text{for } \omega_0 t \gg 0 \tag{60}$$

$$r_0 = \frac{1}{\kappa_0 Z_0}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} = \frac{2\omega_0 t}{\kappa_0 Z_0} = \sqrt{\frac{2t}{\kappa_0 \mu_0}} \tag{61}$$

Though λ_0 is smaller than r_0 and not identical to HEISENBERG's elementary length with it. λ_0 now is in the range of 10^{-68}m. Thus, LANCZOS was wrong in that point. But it only has been a guess on his part. In fact, it's about the wave length of the wave function forming the metric lattice itself. Expression (59) until (61) only represent the temporal functions. Then, the functions of time and space read as follows.

$$\lambda_0 = \frac{2\pi}{\rho_0(2\omega_0 t - \underline{\gamma}_0 r)\kappa_0 Z_0}\operatorname{cosec}\frac{1}{2}\arctan\theta(2\omega_0 t - \underline{\gamma}_0 r) \tag{62}$$

$$\lambda_0 = \pi r_0 \tilde{Q}_0^{-\frac{1}{2}}\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)^{\frac{1}{2}} = \frac{\pi}{\kappa_0 Z_0}\sqrt{2\omega_0 t - 2\beta_0 r} \tag{63}$$

$$r_0 = dr = \tilde{r}_0\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) = \frac{2\omega_0 t - 2\beta_0 r}{\kappa_0 Z_0} \tag{64}$$

The wave length λ_0 of the metrics is irrelevant for the further contemplations of this work, only β_0 matters. The double-bracketed expression in (64) is called *Navigational Gradient* in future. It is the essential expression I was looking for.

We only know the local age T, which results from the local HUBBLE-parameter (65). It quasi represents the temporal distance to the expansion centre. But we are able to determine the spatial distance to the world radius R. This forms a spatial singularity (event horizon) with it.

$$2\omega_0 t - \beta_0 r = \frac{\omega_0(H)}{H} \qquad \text{with} \quad r = 0 \qquad T = \frac{1}{2H} \tag{65}$$

$$R = -\frac{\omega_0(H)}{\beta_0 H} = -\frac{\omega_0 r_0}{H} = -2ct \qquad \text{with} \quad 2\omega_0 t = 0 \tag{66}$$

$$\beta_0 = \kappa_0 Z_0 \sqrt[4]{\frac{\varepsilon_0 H}{\kappa_0}} = \sqrt{\frac{c^3}{G\hbar}} = \frac{1}{r_0} \tag{67}$$

Thus we can get the value of $\beta_0 = 1/r_0$ even from (39), in that we replace the time by the HUBBLE-Parameter. For R turns out:

$$R = -\frac{c}{H} = -1.21880 \cdot 10^{26}\,\text{m} = -1.2918 \cdot 10^{10}\,\text{Ly} = -3.950\ \text{Gpc} \tag{68a}$$

$$R = -\frac{c}{H} = -1.34803 \cdot 10^{26}\,\text{m} = -1.4249 \cdot 10^{10}\,\text{Ly} = -4.36862\ \text{Gpc} \tag{68b}$$

The value (68a) is about 12 billion light years according to Table 2 of [6] according to the standard model. The result (68b) has been calculated using (108) and the CODATA_{2018} values. The local age has the character of a time-constant and amounts only to the half, namely 6.6/7.1 billion years. The local world radius is equal to cT. Longer time-like vectors up to 2cT are possible because of expansion and wave propagation of the metric wave field.

3. Electron and metric system

I want to excuse me once again for the iterations, but the previous sections are essential for the understanding of the following. The latest $CODATA_{2018}$-values are used from this point on. There is no $CODATA_{2022}$-list.

3.1. Physical quantities of special importance

Hence, we want to continue this work with the examination of physical constants, which have large influence on the structure of our world. Most important thereat are the dimensionless constants. One of these is SOMMERFELD's fine-structure-constant.

3.1.1. The fine-structure-constant

The fine-structure-constant α is a characteristic fundamental quantity of DIRAC's theory of the electron. It is a measure for the strength of electromagnetic interaction, i.e. for the coupling of loaded subatomic particles with photons. According to [5] it is defined as follows:

$$\alpha = \frac{e^2}{4\pi\varepsilon_0\hbar c} = \frac{1}{137.035999084} = \frac{1}{4\pi}\cdot 0.0917012 = 0.00729735 \qquad (69)$$

e is the electron charge in this case. The fine-structure-constant has been well proven with the description of the decomposition of the atom-spectra (Lamb-Shift) yet. Also, it is used to explain the dissent between spin and magnetic moment, as it appears with the electron. Now we want to see, whether there is hidden an additional, essential, more fundamental legality behind expression (69).

It is obviously opportune to calculate on the interaction of electrons or protons with photons with the electron charge. In section 4.6.3. of [6] however we have noticed that there is another second charge, namely the charge of the ball-capacitor in the MLE q_0, which is with 3.301378 e near that value (70).We intentionally use a dissenting definition of the PLANCK charge q_0, since the generally accepted definition with α is unfortunate and does not fit the other PLANCK quantities. This obscures relationships to other natural constants.

$$q_0 = \sqrt{\frac{\hbar}{Z_0}} \qquad (70)$$

With a constant in general, it has no influence on the physical content, if we multiply it with another constant. Let’s try now, what happens, if we substitute the electron charge in (69) with q_0:

$$\alpha_0 = \frac{q_0^2}{4\pi\varepsilon_0\hbar c} = \frac{\hbar}{4\pi\varepsilon_0 c\hbar Z_0} = \frac{1}{4\pi} \qquad \alpha = \frac{1}{4\pi}\frac{e^2}{q_0^2} \qquad (71)$$

We have uncovered the nature of SOMMERFELD's fine-structure-constant with it. Following clear statement applies:

> I. *The SOMMERFELD fine-structure-constant is the square ratio of electron charge and charge of the Minkovskian line-element multiplied with a geometrical factor.*

The geometrical factor corresponds to the full space-angle of 1sr and is equal to the factor applied on the calculation of the surface of a ball. This is not further remarkable, have we to do it here with the mutual interaction of two different solutions of the field-equations after all. The first one is the electron (ball), that second one the photon (wave/cube). Indeed, we have uncovered the nature of the fine-structure-constant with it, but it turns out a new question, that we have already asked in the course of this work:

1. *Why does the electron charge just amount to* $0.302822q_0$*?*

This is however not yet everything. From this question and the assumption, that PLANCK's quantity of action is not a constant, arise a row of more questions:

2. *Is the ratio constant between both? If yes, why?*
3. *If no or don't know:*
   Is it a coincidence that the electron charge is close to q_0 *today of all days?*
4. *According to which legality does the value of the fine-structure-constant change or does it remain constant?*
5. *Which effects does it have on other areas of the physics (atomic-model)?*

As fundamental, question 3 crystallizes here, that we cannot answer with absolute certainty however. With great probability, we can say that there is no coincidence. That would mean however, that the electron charge is not constant. Before we'll delve into it, we have to deal with a second dimensionless value.

3.1.2. The correction factor δ

This value occurred with the comparison of several solutions for the HUBBLE-parameter in [1] and I have already seen it in a publication. Unfortunately, I don't remember, in what. Even the search in the internet run into void. Therefore, I cannot tell you the correct name of it. In any case it's not identical with the quantum defect. But in succession, it plays an important role with the set-up of the Concerted System of Units. It is defined as follows:

$$\delta = \frac{4\pi\hbar}{m_p r_e c} = 0.937855101480256 \qquad \text{with the approximation (73)} \qquad (72)$$

$$\delta \approx \frac{1}{\sqrt{2}}\frac{Q_{2/3}}{Q_{1/2}} = \frac{1}{\sqrt{2}}\frac{2/3}{1/2} = \frac{2}{3}\sqrt{2} = 0.942809 \qquad \Delta = +5\cdot 10^{-3} \qquad (73)$$

Furthermore, following important relation applies: $\frac{m_e}{m_p} \approx \frac{1}{1836} = \text{const}$

$$\alpha\delta = 4\pi\frac{m_e}{m_p} = 6.84386\cdot 10^{-3} \approx \frac{1}{146} \qquad \delta = \frac{4\pi}{\alpha}\frac{m_e}{m_p} \Leftarrow \text{def} \qquad (74)$$

To avoid a circular reference we make use of the right-hand expression (74) to the definition of δ. Obviously, with δ it's about a correction factor which should compensate the eccentricity between proton and electron in the ^1H-atom of BOHR's classic atom-model, since m_e is not small enough with respect to m_p, it wobbles. Well, BOHR's model is not correct in fact. Nevertheless, values thereof, such as r_e, do a good service with calculations even this very day. That also applies to δ, as we shall see later. Apparently, because of (74) it's about a kind of complementary fine-structure-constant. As latest, more exact research [8] suggest, the ratio m_e/m_p turns out to be constant. It varies by max. $-5.0\cdot 10^{-17} a^{-1}$, i.e. with an age of only $1.4\cdot 10^{10}$a it's quasi constant. I agree with this statement, because this model is based on this assumption.

3.1.3. The electron charge

3.1.3.1. Static contemplation

Already DIRAC has formulated a hypothesis, as per which electron charge is a function of time, (DIRAC's hypothesis). In his model the gravitational »constant« is not a constant too. That means, one cannot exclude this possibility and it is worthwhile in any case, to engage further examinations at this point. If we assume to be no coincidence, that the charge of electron is near q_0, so it's also obvious, to say that a ratio exists between the two values, which acts according to a certain inherent law.

The definition of q_0 contains the PLANCK's quantity of action, which is of essential meaning nevertheless for the theory of the bosons (e.g. photons) as for fermions (e.g. electrons) – combined with the wave-propagation-impedance Z_0 of the vacuum. This suggests the conjecture that both charges are actually one and the same, at which point the electron charge, on the basis of particular conditions, only *seems* to be smaller. Therefore we want to examine, whether it is possible to calculate the electron charge from the charge q_0 of the MINKOVSKIan line-element. Let's have a look at the model according to Figure 8 for that purpose.

We have yet noticed that the basic condition of the metrics is located near the expansion centre (0) at a Q-factor of Q=1/2 (1). The expansion-graph in this area is sketched in Figure 8. Furthermore, we have noticed that there must be something like a basic condition even for the fermionic matter, whereby we can observe both types of matter only red-shifted through the *lens* ($\hbar$) of the metrics. It turns out the question: What's the Q-factor, the basic condition of the fermionic matter is located at?

The most obvious assumption would be, that it is at the point Q=1/2 too. Now, we have noticed that this point (1) forms the aperiodic borderline case, in which no periodic wave-function can exist anyway. This however, is a necessary condition for the existence of e.g. the electron as matter-wave (DEBROGLIE). Matter-waves are moving, according to our definition, opposite to the propagation direction of the metrics, which has the consequence, that they don't move anyway. They persist quasi on the position forming standing waves. Furthermore arises, that these waves, in contrast to time-like vectors, cannot surmount the (3) point Q=1, in which a phase-jump appears, since they are been reflected there. With it, a matter-wave would be „locked up“ between the points 1 and 3.

Now, we further assume, that in reality, the electron also has the charge q_0, of which we only can *see* the share e, since the electron is warped about an angle β into the phase space in reference to the observer, who is positioned far on the r-axis. Just like the universe the electron is a four-dimensional object. Because the charge q_0 is evenly distributed over the surface, it is quite possible, that we may even be able to *see* only a part of the surface, and with it, only a part of charge, due to the curvature-ratio.

The (shifted) r-axis is the asymptote of the expansion track-curve. It behaves like a parabola near the origin, farther, like a hyperbola (Figure 7) and on a large scale like a 1:1 straight line in the 4^{th} quadrant (Figure 25 [6]). We are primarily interested in the angle ε, which results from the argument of the integral of the complex propagation velocity $\underline{c}$ of the metrics (27). It applies:

$$\varepsilon = \arg \int_0^T \underline{c}\,dt = -\arg j2 \int_0^T \frac{1}{2\omega_0 t} \frac{dt}{\sqrt{1-\Theta^2(2\omega_0 t)}} \qquad (75)$$

At this point the integral of $\underline{c}$ and not the value itself comes into effect, since not the velocity $\underline{c}$ of the electron but his location is of interest for the further calculations. With the help of (30) we are able to transform (75) in the following manner:

$$\varepsilon = -\arg c \int_0^T \frac{1}{\rho_0 \omega_0 t}\left(\cos\frac{1}{2}\arg\theta + j\sin\frac{1}{2}\arg\theta\right)dt = \arg 2c \int_0^T \frac{1}{2\omega_0 t \rho_0} e^{-j\frac{1}{2}(\arg\theta+\pi)}dt \qquad (76)$$

The integral with respect to time is not particularly well-suited however, since the frequency ω_0 itself is a function of time. Therefore we substitute t by the phase-angle $Q=2\omega_0 t$ obtaining for the angle ε and for the amount of the zero-vector r_N:

$$Q = \sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \qquad dQ = \frac{1}{2}\sqrt{\frac{2\kappa_0}{\varepsilon_0}}\, t^{-\frac{1}{2}}dt \qquad dt = \frac{\varepsilon_0}{\kappa_0} Q\, dQ \qquad (77)$$

$$\varepsilon = \arg r_1 \int_0^Q \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ = \arg \int_0^Q \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \qquad (78)$$

$$r_N = \left| Z r_1 \int_0^Q \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \right| \qquad Z = \frac{R(Q)}{r_0(Q)} = \frac{H_1 R}{H_0 r_0} = \frac{3}{2} Q^{\frac{1}{2}} \qquad (79)$$

with $r_1=1/(\kappa_0 Z_0)$. Although, the left expression of (79) is not yet complete. It only describes the propagation of the wave. It still lacks the expansion-share Z of the constant wave count vector r_K across the entire world-radius R, otherwise applies $Z=2mQ^{1/2}$ see (328 [1]). It has the characteristic of a zoom-factor and is to be placed before the integral, since it influences all elements dr simultaneously (see section 4.5.2. [6] or [7]). Altogether applies:

$$r_N = \left| \frac{3}{2} r_1 Q^{\frac{1}{2}} \int_0^Q \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \right| \qquad -j\frac{1}{2}(\arg\theta+\pi) = j\frac{1}{2}\arctan\theta = j\phi_0 \qquad (80)$$

Now certainly an analytic solution of this integral can be found, if there is enough time. This however would go beyond the scope of this work. Therefore, we determine the integral with the help of the »Mathematica«-function NIntegrate numerically. With it however the function $1/\rho_0$ makes particular difficulties, namely because of the many nulls of the Bessel function. In order to make possible an exact solution nevertheless, we substitute the expression $1/\rho_0$ by an interpolation-function with list (function Interpolate). Then, expression (78) Ep[Q] and (80) Rn[Q] can be calculated as follows (without r_1):

```
cMc = Function[-2 I/#/Sqrt[1 - (HankelH1[2, #]/HankelH1[0, #])^2]];
PhiQ = Function[If[# > 10^4, - Pi/4 - 3/4/#,
Arg[1/Sqrt[1 - (HankelH1[2, #]/HankelH1[0, #])^2]] - Pi/2]];
RhoQ = Function[If[# < 10^4,
N[2/#/Abs[Sqrt[1 - (HankelH1[2, #]/HankelH1[0, #])^2]], 1/Sqrt[#]]];
rq = {{0, 0}};
For[x = -8; i = 0, x < 4, ++i, x += .01;                               (81)
AppendTo[rq, {10^x, N[10^x*RhoQ[10^x]]}]];
RhoQ1 = Interpolation[rq];
RhoQQ1 = Function[If[# < 10^4, RhoQ1[#], Sqrt[#]]];
Rk = Function[If[# < 10^4, 3/2*Sqrt[#]*NIntegrate[RhoQQ1[x], {x, 0, #}], 6 #]];
Rn = Function[Abs[3/2*Sqrt[#]*NIntegrate[RhoQQ1[x]*Exp[I*(PhiQ[x])], {x, 0, #}]]];
RnB = Function[Arg[NIntegrate[RhoQQ1T[x]*Exp[I*(PhiQ[x])], {x, 0, #}]]];
```

The absolute error is smaller than 10^{-7}. Then the electron charge is the rectangular mapping of the charge q_0 upon the r-axis as presented in Figure 8:

$$\sin\gamma = \cos\beta = \sin\left(\frac{\pi}{4} - \varepsilon\right) = \frac{e}{q_0} \qquad e = q_0 \sin\gamma \qquad \alpha = \frac{1}{4\pi}\sin^2\gamma \qquad (82)$$

The exact calculation with the help of the function FindRoot using the CODATA_{2018}-values for the basic condition of the electron turns out the value $\varepsilon=-2.0485420678463937$ resp. $\varepsilon=-0.6520711924588928\pi$ with $Q=0.6567290175491683$. Because the observer, to the point of time $T \gg t_1$, is located (approx.) directly on the r-axis, the electron charge calculates from the real charge of the electron q_0 multiplied with the sine of the angle-difference between the phase-angle of the electron in base state and the phase-angle of the observer ($-\pi/4$) as $e=0.3028221208819746 q_0$).

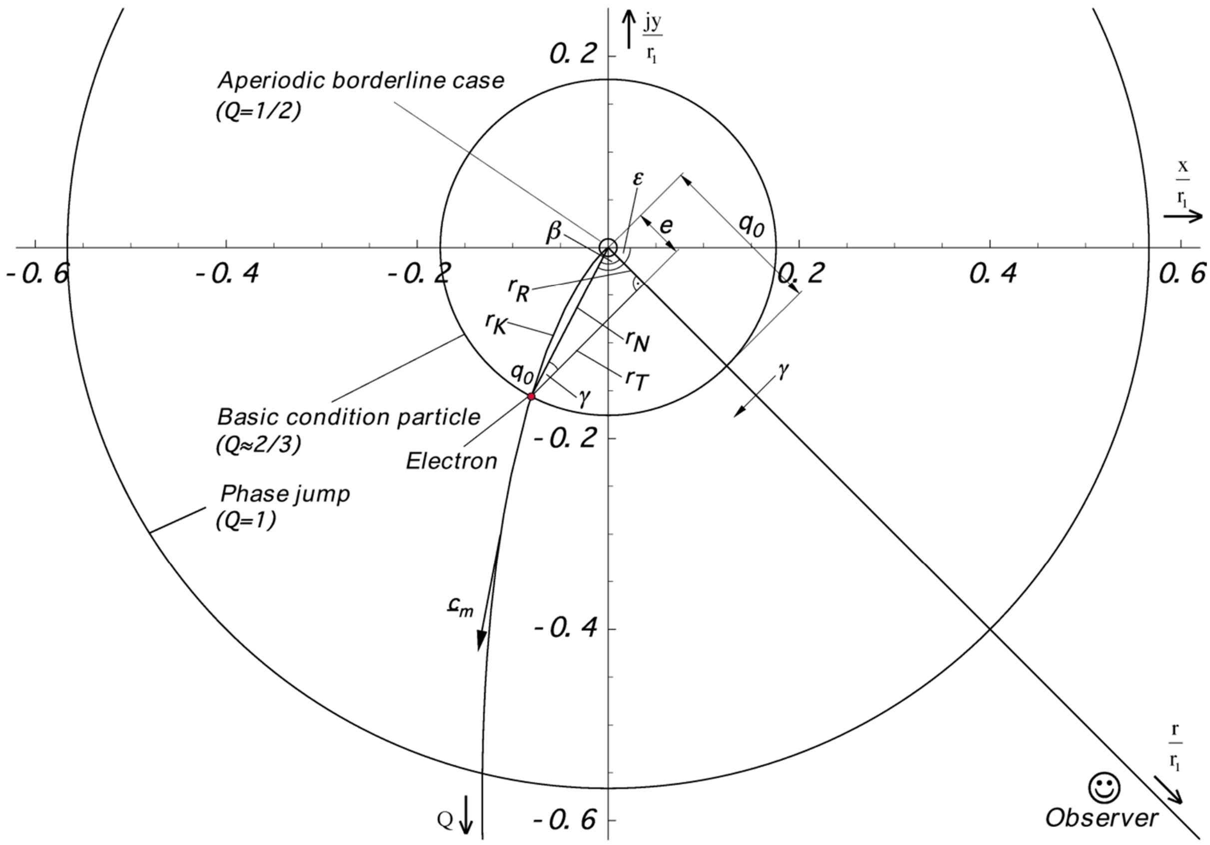

Figure 8
Ratio of electron charge and charge of the MLE in the phase space of the electron

This is nearly constant over a large area. With it, the electron charge traces the charge q_0 of the MLE directly. Thereby, the very small variation of α by approximately $-0{,}20\cdot10^{-16}a^{-1}$, stated in [8], is no contradiction. Only on extremely relativistic conditions, the ratio between q_0 and e varies according to Figure 11.

With the fine-structure-constant itself it are just actually about two different „constants" which only coincides to the present point of time. Firstly it's about the ratio of the observed to the actual electron charge, secondly about the angle of intersection between electron and photon. It can be interpreted even like that the charge of the electron itself is a wave-function and it's periodic. Because of the spin (rotation) the measured charge is a function of the angle of incidence α then (Figure 8).

On this occasion, the photon always incidents with the angle $-3/4\pi$ This corresponds to the real-part, because only this is able to perform work during an interaction. During the calculation of action, we must multiply with the value $\sin\gamma_\gamma$ therefore. The same is applied also to the interaction with neutrinos (inverse b-decay $\bar{\nu}+p\rightarrow n+e^+$). Latter one also today yet figures one of the some many options to the proof of neutrinos. First of all, only the extremely small real-part (in this case), becomes effective during the reaction of the proton with the antineutrino, which leads to the so small effective cross-section. Then, in the subsequent reaction of course the entire neutrino is absorbed, including the „blind energy".On higher velocities (near c), near the particle-horizon or even in strong gravitational-fields thus the uniform „constant" splits into two different variables. The weak interaction becomes strong quantitatively seen, since the neutrinos behave like photons then. At the same time there's going to be a symmetry-breaking.

However back to the electron: While the basic condition of the metrics is settled at Q=1/2, we have found a value of Q=0.656729 for the electron, but we expected a value of Q=2/3. Using Q=2/3, we obtain a value for e, which is about 2.54% beyond the really observed one. How this deviation can be interpreted?

As is generally known, the fine-structure-constant is used in the interpretation of interaction-processes between electron and photon, at which point the observer usually is located far away on the constant wave count vector r_K at a point $Q\gg 1$. In a large distance, this coincides with the r-axis. Even the electron as a fermion only moves along the constant wave count vector. Since the Q-factor is identical to the phase-angle of the Hankel function, it is defined along r_K, i.e. along the arc. The wave-function of the electron shows a certain curvature with it. The photon itself, the zero vector r_N in contrast, is rectilinear i.e. not curved. Since it's about a photon, which is observed at a point with $Q\gg 1$ the angle α is extremely close to $\pi/2$.

The real interaction indeed takes place in the basic condition of the electron at Q=2/3 i.e. the zero vector is being up scaled with all its angles to the phase space of the electron. The result of the interaction on the other hand is being observed downscaled at $Q\gg 1$ then. And an adaptation occurs obligatorily during the real interaction (stretching) of the curvilinear wave-function of the electron onto the non curvilinear zero vector. For this reason, it is of interest to determine the arc length of r_K. Even if we weren't able to find any analytical solution for (80), we can say yet, that the determination of the arc length is not impossible. With the help of (76) we obtain:

$$r_K = \int_{t_1}^{t_2} \sqrt{\dot{x}^2 + \dot{y}^2}\,dt = \frac{\varepsilon_0}{\kappa_0} \int_0^Q Q\sqrt{x'^2 + y'^2}\,dQ \tag{83}$$

$$r_K = r_1 \int_0^Q \frac{Q}{Q}\frac{1}{\rho_0}\sqrt{\cos^2\frac{1}{2}\arg\theta + \sin^2\frac{1}{2}\arg\theta}\,dQ = r_1 \int_0^Q \frac{dQ}{\rho_0} \tag{84}$$

This is however only the share of the wave-propagation in turn. Together with the expansion-share, this is applied to the arc length too, we get:

$$r_K = \frac{3}{2} r_1 Q^{1/2} \int_0^Q \frac{dQ}{\rho_0} = \frac{3}{2} r_1 Q^{1/2} \int_0^Q \frac{dQ}{\sqrt[4]{(1-A^2+B^2)^2 + (2AB)^2}} \overset{\text{def}}{=} R(Q) \tag{85}$$

Also for the expression (85) there is certainly an analytic solution, this is however still too complicated, so that we will determine this integral numerically too, at least for small values Q, because to large values, the approximation $2/\rho_0 \approx Q^{1/2}$ is applied and the integral turns analytically solvable with it:

$$r_K = \frac{3}{2} r_1 Q^{1/2} \int_0^Q \frac{1}{\rho_0}\,dQ \approx \frac{3}{2} r_1 Q^{1/2} \int_0^Q Q^{1/2}\,dQ = r_1 Q^2 \qquad Q\gg 1 \tag{86}$$

This is a known relation, which we have derived with it. It is applied however only to values $Q\gg 1$. For the numerical determination of the integral we apply usefully the following expression in »Mathematica«:

```
Rk = Function[If[# < 10^5, 3/2*Sqrt[#]*NIntegrate[RhoQQ1[x], {x, 0, #}], 6 #]];
```
(87)

Now, we are particularly interested in the ratio between r_K and r_N. The course is presented in Figure 9 with and without expansion-share. Namely, the expansion-share cancels out in this case. To the calculation we use the function rs. For a faster calculation we generate the interpolation function RS[Q] (see annex).

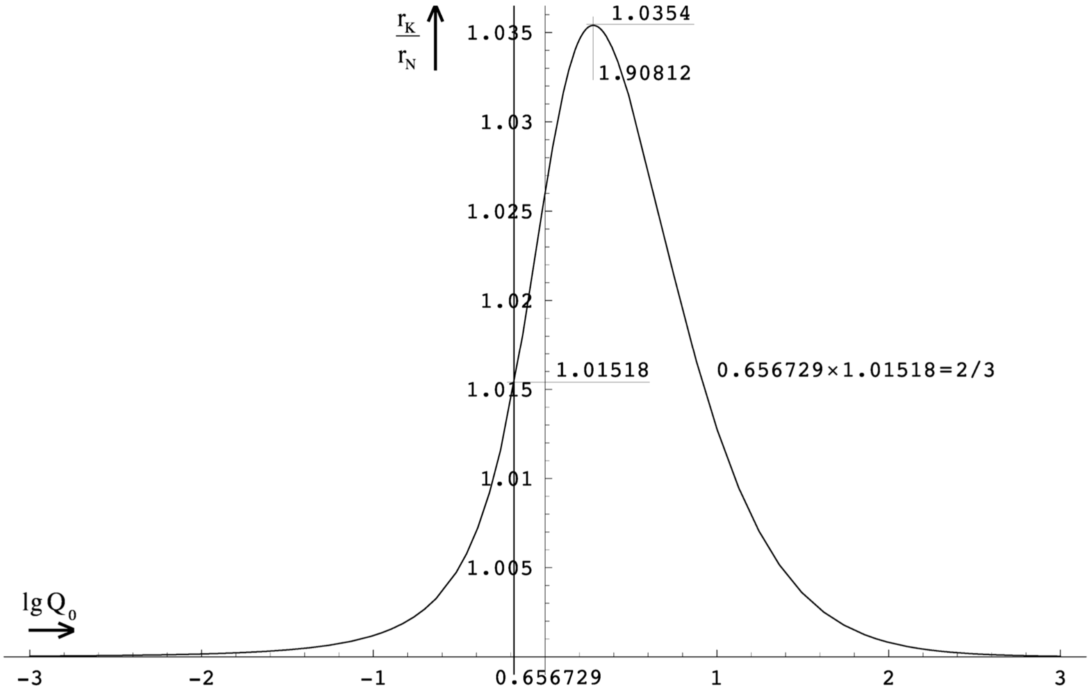

Figure 9
Ratio between the length of the constant wave-count vector r_K and the length of the zero vector r_N as a function of Q_0

And it shows following at this point: If we assume the basic condition (r_N) of the electron to be at Q_0=0.6567290, so the associated constant wave count vector r_K is exactly about 1.0151827890 longer. If we however multiply the phase-angle $Q_0=2\omega_0 t$=0.6567290 with the latter one, a value of 0.666699995 turns out. Except for a deviation of only $4{,}99935\cdot 10^{-5}$ it equals 2/3. The reason could be the computational error during the numerical integration. Having duplicated the precision of the calculation however, we got exactly the same result up to the last position. It could even be about a systematic error then or about others, not considered influences during the determination of electron charge in the experiment or about a misinterpretation. Also possible is, that the value in fact is not exactly at 2/3 but at 0.6567290.

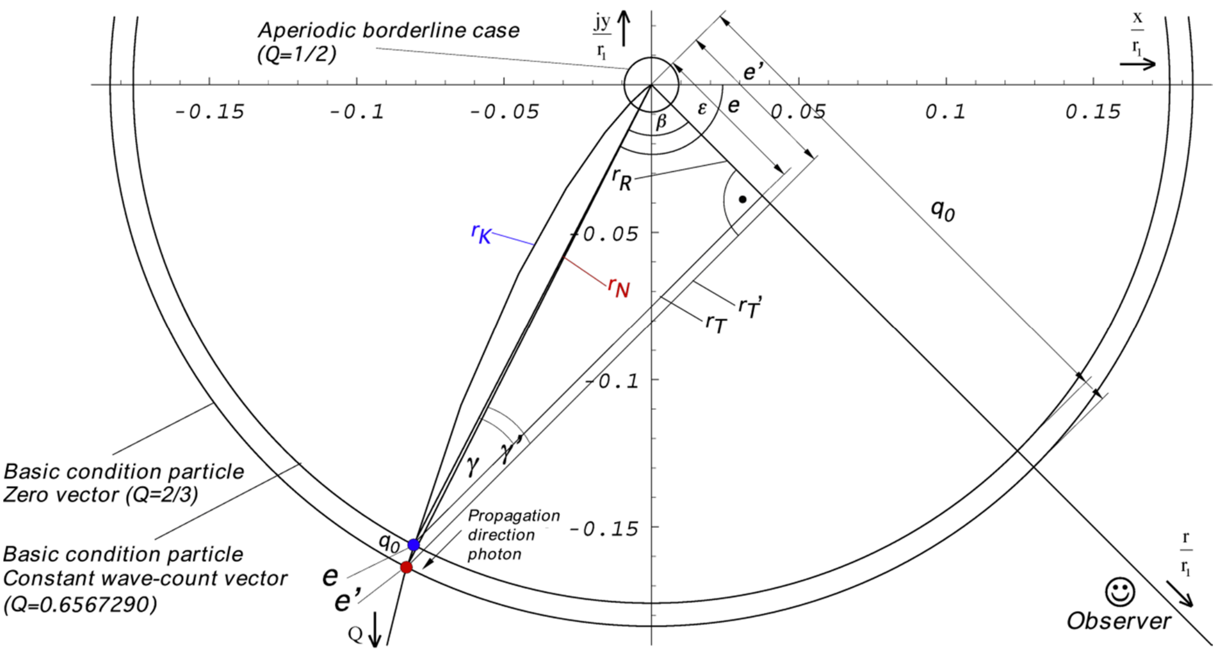

Figure 10
Ratio of electron charge and charge of the MLE
in the phase space of the electron (larger scale)

In Figure 10 the exact relations are presented in a larger scale once again. One recognizes the two basic conditions of the electron e (blue) and e′ (red), at which point more final should be equal to the stretched constant wave count vector of e. This is not the case by the way, since the angle ε and with it also β varies negligibly with the stretching. We determine the lengths of r_K as well as r_N for the three values to:

$$r_K(0.656729017) = \frac{3}{2} r_1 \sqrt{0.656729017} \int_0^{0.656729017} \frac{dQ}{\rho_0} = 0.178514 r_1 \qquad (88)$$

$$r_N(\frac{2}{3}) = \left| \frac{3}{2} r_1 \sqrt{\frac{2}{3}} \int_0^{2/3} \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \right| = 0.183660 r_1 \qquad (89)$$

$$r_N(0.666699995) = \left| \frac{3}{2} r_1 \sqrt{0.666699995} \int_0^{0.666699995} \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \right| = 0.183687 r_1 \qquad (90)$$

It shows, there is no match in length. Even if we deduct the expansion-factor from the result we always get a deviating result (the best fit would be at a phase-angle of 0.660147). That means, the basic condition e is only nearby Q=2/3 i.e. with 0.656729017. That doesn‘t conflict with other findings of [1] and plays a subordinated role with it. The exact 2/3 was just a guess of mine anyway. The only thing, that matters, is the angle ε=−2.0485420678463937. Now, we already want to calculate the corresponding charges:

$$q_0 \sin\left(\frac{\pi}{4} - \arg \int_0^{0.656729017} \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \right) = e \qquad (91)$$

$$q_0 \sin\left(\frac{\pi}{4} - \arg \int_0^{2/3} \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \right) = 1.0253956 e = e' \qquad (92)$$

I would denominate condition e′ as excited state of the electron. With it, we have proven, that it is possible, to find a relation between the charge e of the electron and the PLANCK-charge q_0. Maybe, these two charge-bearing particles are actually identical, on the one hand as free particle (electron), on the other hand bound in the metrics…?

3.2.2.2. Dynamic contemplation

We have determined yet that the electron charge is (could be) equal to the rectangular mapping of the charge q_0 of the MLE onto the metrics-axis of r. What happens now, if the observer moves with a certain velocity or is located in an area of strong curvature or quite simply, what's the spatial and temporal dependence of the electron charge?

If the observer is moving with a relative-velocity different from zero in reference to the coordinate-origin, he is, in terms of physics, moving backwards on the expansion-graph in the direction to the zero point. The same is applied in the proximity of a strong gravitational-field or that of the particle-horizon. The temporal dependence is inverse. In the natural time-direction, he moves away from the zero of the expansion-graph. All that depends on the value $\tilde{Q}$ (frame of reference), on time, distance, speed and/or the gravity potential. In order to determine the dependence, let’s have a look at the model according to Figure 8. At first, we will determine the dependence with respect to the phase-angle Q.

If the observer is located far away on the r-axis, so the phase-angle ε–β of the metrics, that's the vector from origin to the observer staying on the expansion-graph, amounts to (approx.) –π/4 (r-axis). The r-axis forms the asymptote of the expansion-graph. If we now approach the origin, the value of the angle becomes greater (the r-axis turns to the left). Now, the charge arises to $e'=q_0 \sin\gamma'$ (not identical to e′ and γ′ of Figure 10). On this occasion the right angle (α) survives, because with the turnover also the propagation direction of the photons changes. Then, under application of (85) and (86) in the triangle $e' r_T' q_0$, we obtain the following relations:

$$\gamma = \pi - \frac{\pi}{2} - \beta = \frac{\pi}{2} - \left[-\varepsilon + \arg \int \underline{c}\, dt \right] \tag{93}$$

$$\sin\gamma = \sin\left(\frac{\pi}{2} + \varepsilon - \frac{3}{2} Q^{\frac{1}{2}} \int_0^Q \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \right) \tag{94}$$

```
RnB = Function[Arg[NIntegrate[RhoQQ1[x]*Exp[I*(PhiQ[x])], {x, 0, #}]]];
Plot[{Sin[(Pi/2 - RnB[10^t7] + ϵ}, {t7, -8, 8}]
```
(95)

For a faster calculation I defined the interpolation function RNBP[Q], for sin γ the function QQ[Q] (see annex). The course of the corresponding function in dependence on Q is shown in Figure 11. We see clearly, that the ratio electron charge and PLANCK charge is nearly constant over a wide reach. With the fine-structure-constant it's really about a genuine constant, at least for the these days technically accessible range. But, approaching the origin, e.g. with very fast speed near c, the ratio changes. The maximum is at Q=0.656795 behind the particle horizon.

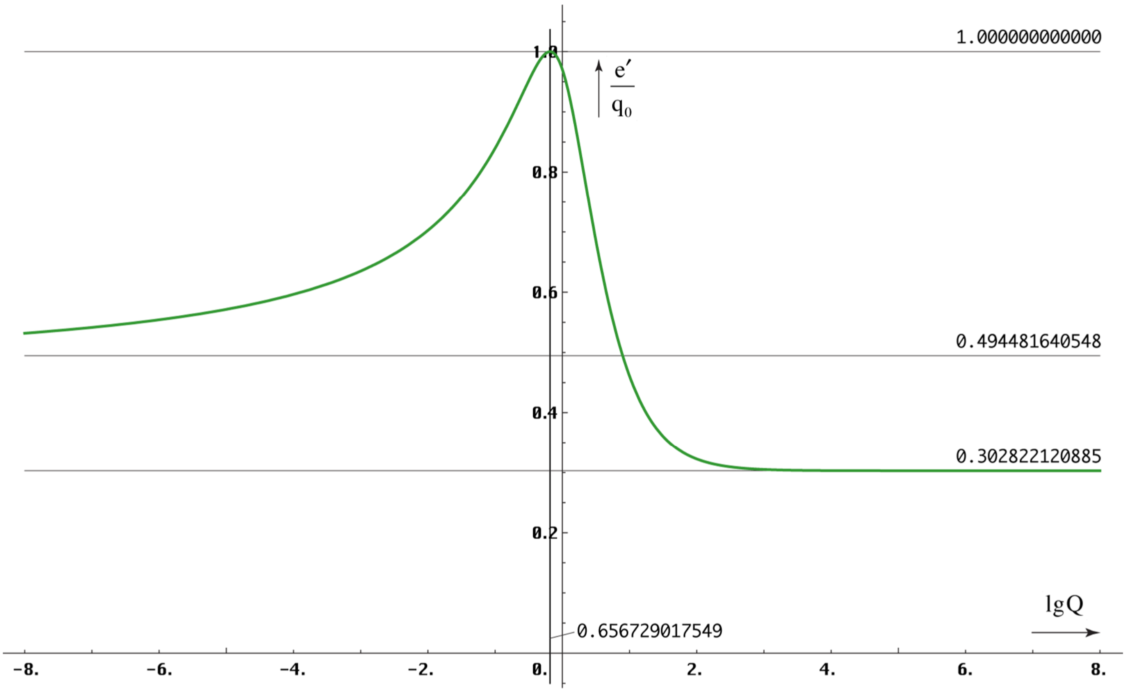

Figure 11
Ratio of electron charge and of the PLANCK charge
as function of the phase angle Q according to (94)

Btw., Figure 118 in [1] shows the temporal dependence and not that on Q. In the approximation $|\underline{c}| \sim Q_0^{-1/2} \sim t^{-1/4}$ applies. With it, we determined the dependence e′(Q). But we are rather looking for the function e′(v). Most simply it would be, if we could determine Q(v). In section 6.1.2.1. of [6] we already found with (696 [6]) the expression $Q=c^2/v^2$. But we cannot use it here, because it only applies to a non-accelerated frame of reference. The item v is the speed $|\underline{c}|$ with respect to the r_1-lattice of subspace in this connection. If we accelerate, our frame of reference gets lost and we get a new one, in which most of the base values, even v, have taken on another value. Indeed, expression (696 [6]) applies-on, however with another value of v. Thus, we cannot simply add the speed after acceleration to the value $|\underline{c}|$, at least *not linearly*, but *geometrically*. Therefore, we have to find another, better expression here.

We are moving on the constant wave count vector r_K. If we look at expression $r=\int \underline{c}\,dt$ more exactly, so $\underline{c}$ depends on the time dt. Thus, we have to replace dQ with dt at first. Based on (86) without expansion applies:

$$r = \int \underline{c}\,dt = \frac{3}{2} r_1 \int_0^Q \frac{2}{\rho_0} dQ \approx \frac{3}{2} r_1 \int_0^Q Q^{\frac{1}{2}}\, dQ \qquad Q = \sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \tag{96}$$

Reference point is the expansion centre $\{r_1,r_1,r_1,t_1\}$ in this connection. Now let's substitute dQ by dt with the ansatz:

$$dQ = \frac{1}{2}\sqrt{\frac{2\kappa_0}{\varepsilon_0}}\, t^{-\frac{1}{2}}\, dt = \sqrt{\frac{\kappa_0}{2\varepsilon_0 t}}\, dt \tag{97}$$

$$dt = \sqrt{\frac{2\varepsilon_0 t}{\kappa_0}}\, dQ = \frac{\varepsilon_0}{\kappa_0}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}}\, dQ = \frac{Q}{\omega_1} dQ \tag{98}$$

Plugged into the integral we obtain then:

$$\int \underline{c}\,dt \approx \frac{3}{2} c \int Q_0^{-\frac{1}{2}} dt = \frac{3}{2}\frac{c}{\omega_1}\int Q^{\frac{1}{2}}\, dQ = r_1 Q^{\frac{3}{2}} \tag{99}$$

$$\int \underline{c}\,dt \approx r_1 Q^{\frac{3}{2}} = r_1 \left(\frac{2\kappa_0 t}{\varepsilon_0}\right)^{\frac{3}{4}} = \left(\frac{2\kappa_0^{-1/3} t}{\varepsilon_0^{1/3}\mu_0^{2/3}}\right)^{\frac{3}{4}} = \left(\frac{2c^2}{\mu_0\kappa_0}\right)^{\frac{1}{4}} t^{\frac{3}{4}} = c\sqrt[4]{4 t_1 t^3} \tag{100}$$

We can't do much with that either, as we've only proven, that the world radius R/2=ct is, without consideration of expansion, proportional $Q^{3/2}$ resp. $t^{3/4}$ in the approximation.

If speed comes into play, we always have to do with more than one reference system and with measurements of physical quantities we have to perform a LORENTZ-transformation. We have stated in [6], that wave-lengths are stretched according to $\lambda \sim Q^{3/2}$. The same applies to the size of material bodies, whereas the PLANCK-length r_0 is ~Q only. Otherwise no redshift would be detectable. With the LORENTZ-transformation the wave-length λ depends on the inverse LORENTZ-factor $\beta=(1-v^2/c^2)^{-1/2}$, it applies $\lambda'=\beta^{-1}\lambda$. However, this must not be confused with the formula for the relativistic DOPPLER-shift. With it, we are able to formulate expres-sions for the dependence $Q=f(v)$:

$$Q'_0 = \tilde{Q}_0\left[1-\frac{v^2}{c^2}\right]^{\frac{1}{3}} \qquad \frac{v}{c} = \sqrt{1-\left(\frac{Q'_0}{\tilde{Q}_0}\right)^3} \qquad \beta = \left(\frac{Q'_0}{\tilde{Q}_0}\right)^{-\frac{3}{2}} \tag{101}$$

$$Q^{3/2} \sim t^{3/4} \sim \beta^{-1} \sim (z+1) \qquad Q \sim t^{1/2} \sim \beta^{-2/3} \sim (z+1)^{2/3} \tag{102}$$

$\tilde{Q}$ is the value in the observer's frame of reference. In order to ensure an exact calculation even for velocities extremely close to c, it's a good idea, to increase working precision. In Mathematica/Alpha it happens with the help of the function SetPrecision with an allocation to an auxiliary variable inside the definition of the function:

```
Qυ = Function[a4712 = SetPrecision[#2, 309]; #1*(1 - a4712^2)^(1/3)];    (*Q(υ/c, all Q~)*);
Qυ0 = Function[a4713 = SetPrecision[#, 309]; Q0*(1 - a4713^2)^(1/3)];    (*Q(υ/c, Q0)*);
υQ = Function[a4714 = SetPrecision[(#2/#1)^3, 309];
  Sqrt[SetPrecision[1 - a4714, 309]]];                                   (*υ/c(Q, all Q~)*);
υQ0 = Function[a4715 = SetPrecision[(#/Q0)^3, 309];
  Sqrt[SetPrecision[1 - a4715, 309]]];                                   (*υ/c(Q, Q0)*);
```

(103)

With it, it's possible, to specify the ratio e/q_0 as a function of velocity v exactly. Unfortunately, the graphic resulting from, is underwhelming, unless we work with the logarithm of the difference $(1-v^2/c^2)$. But the function α at first. Because of (94) and (101), both are no constants in fact, but reference-system-dependent.

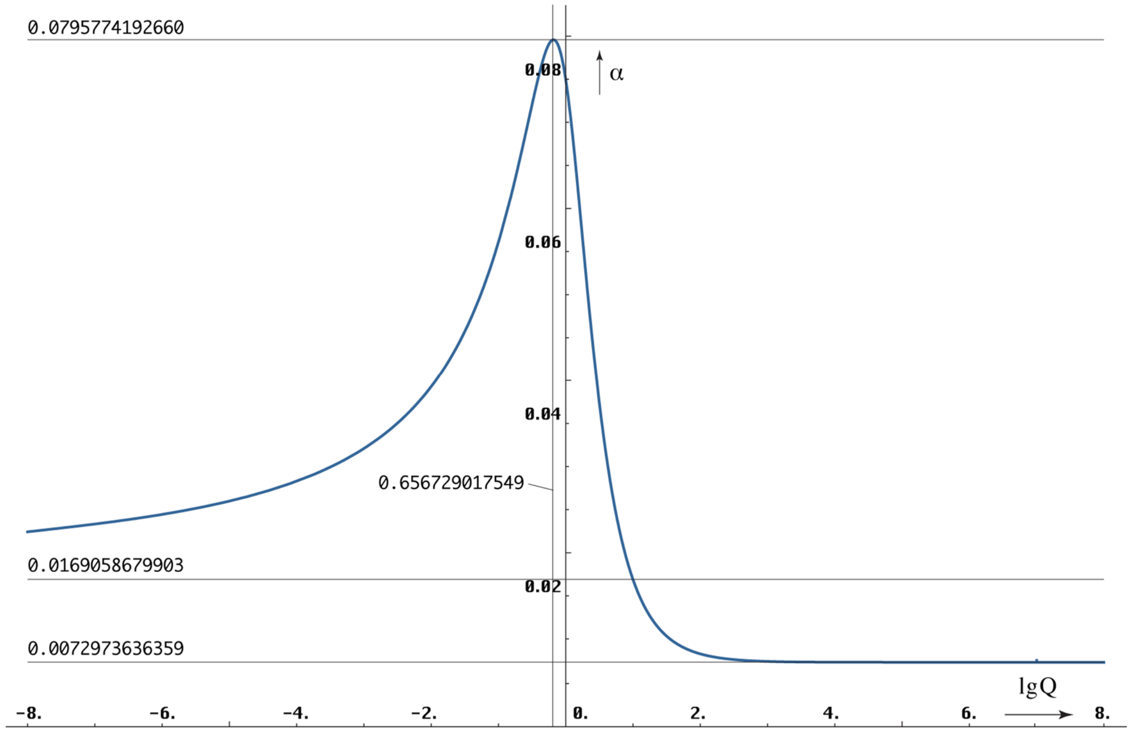

Figure 12
SOMMERFELD's fine-structure-constant
α as a function of the phase angle Q

In this context I have to disappoint the astronomers. The fine-structure-constant varies with time and distance indeed, but the change of α comes into effect only from approx. 10^{-90}m off the particle horizon (world radius) on.

The same applies even to the course as a function of time t after BB, depicted by means of the function δ. So you have to find another explanation for the quasar-problem, unless, these are located outside our universe. Possibly it's about the effigies of our neighbour-universes? But then they should be arranged in the form of a crystal lattice. Take a look and see, if there is also a quasar in the opposite direction. But now enough of speculation.

Further to the correction factor δ. Because of (74) the function has a shape like α^{-1} (right-hand ordinate). For δ the left ordinate applies. The t- and the Q-axis apply to both at once. The t-values arise from (96). Somebody will have doubts at this point, if we really can reckon-back so far in time. It has to be said, that with Q nearly all other natural constants vary too. Shortly after BB photons behave like neutrinos and vice versa. However, the course less than Q=½ in Figure 11-13 is probably theoretical, since the base state of the photon is at ½, that of the electron at approx. ⅔. Besides from that, the metric wave field is not completely established until Q=½. It's even about a model.

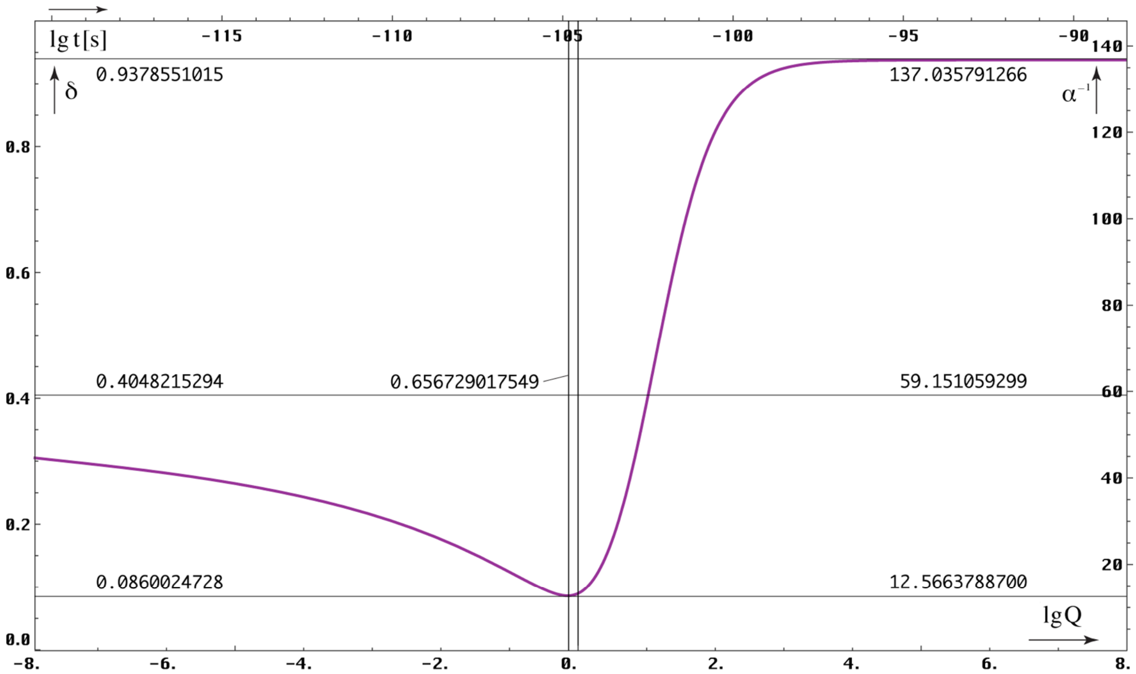

Figure 13
Correction factor δ and reciprocal of the fine-structure-constant α as a function of time after BB and of the phase angle Q

Even if the ratio e/q_0 is quasi constant everywhere, it nonetheless depends on time, speed, distance and the gravitational potential i.e. the frame of reference Q_0. The same applies to PLANCK's quantity of action $\hbar$. Because of (23) applies:

$$e \sim q_0 \sim Q_0^{-\frac{1}{2}} \qquad \hbar = q_0^2 Z_0 = \frac{e^2 Z_0}{\sin^2\gamma} \sim Q_0 \tag{104}$$

Thus, in the predominant part of the universe, spatial and temporal, α and δ are constant. Nevertheless, the previous contemplation is important for the determination of the base state of the electron mass with Q=1.

3.1.4. The electron mass

3.1.4.1. Static contemplation

Having stated, that I hadn't considered the electron mass m_e in my work before, I searched for a relation, with which it can be calculated from the PLANCK-mass m_0 resp. vice versa. In contrast to the charge, which resides on the surface, with the electron mass even the inner, invisible part comes into effect. Therefore, a behaviour like in the previous section is not to be expected. By trying, with the values from [1] and a phase angle Q_0=7.95178·10^{60}, based on expression (1049 [6]) $Q_0 = \frac{3}{2}(r_e/r_0)^3$, I found the following expression:

$$m_e \approx \frac{1}{12\pi^2} m_0 Q_0^{-1/3} = 9.20759 \cdot 10^{-31}\,\text{kg} = 1.01078 m_e \qquad m_0 = \sqrt{\frac{\hbar c}{G}} \tag{105}$$

Interestingly enough, this value is near to the real one amounting to 9.10939·10^{-31}kg. Thus, it seems to be possible, to calculate m_e. In [1] I already set-up a program, with which most of the universal natural constants could be calculated from 10 fixed values. The electron mass was one of the input parameters. The value Q_0 has been determined using (1049 [6]). This way, it was possible to calculate the specific conductivity of the vacuum κ_0, so that the values can be determined top down too. But it was impossible, to calculate all values and there was always a residual error. In actual fact, there are even only four values, which can be fixedly defined. These are the three invariants of subspace c, μ_0, κ_0, and k, as well as the ones, depending on them ε_0 and Z_0, furthermore the value $\hbar_1$, the initial action of the universe shortly after BB (Q=1). The reason is, that these as the only ones, really do not change at all. Neither, they do not depend on any system of reference.

Except for the meter and the second, which are exemplarily defined, CODATA unfortunately took a different part with the other values, in that they fixedly defined particular values arbitrarily, e.g. $\hbar$, latter one to the recent definition of the kilogram. The whole issue is quite problematic, especially since $\hbar$ depends on the frame of reference. Now I tried to optimize the lot, in order to improve accuracy. Extremely important is, that the kilogram won't be modified at all. Otherwise millions and millions of scales would have to be recalibrated. Also I act on the assumption, that the CODATA-values are pretty accurate.

Indeed, these have been determined by a kind of iterative process. Lab A determines the value a with a certain accuracy. Another lab validates a with another accuracy. Based on a lab B determines value b even with another accuracy. Based on a and b lab C determines…etc. This way we approach the real values more and more. The more exactly we measure, the more deviations carry weight, being based on the arbitrary predefinition of e.g. $\hbar$ and on the fact, that the lab, value a should be validated by, is in the middle of nowhere, e.g. at a point, the apparent gravity has a different value. The earth is not a ball anyway, but a geoid. So it becomes important more and more, to find a method, with which these deviations can be calculated out.

But further with the electron mass. Just like (890 [1]) and (1049 [6]) expression (105) offers an oppor-tunity, to determine the value Q_0. We need it to calculate-up to the initial values, mainly for κ_0. It applies:

$$Q_0 \overset{?}{=} \left(\frac{1}{12\pi^2}\frac{m_0}{m_e}\right)^3 = 8.20969 \cdot 10^{60} \tag{106}$$

The value differs from the one determined in [1] and depends from m_0 and m_e. The further way leads over the combination of the charge- and mass-path on the initial level, thus $e \rightarrow q_0 \rightarrow q_1 \rightarrow \hbar_1\omega_1 = M_2c^2 \leftarrow M_1c^2 \leftarrow m_0c^2 \leftarrow m_ec^2$. Thereafter, we are able to determine κ_0 and G. An important side condition is (74). The whole issue is similar to Sudoku. If the numbers finally add up without deviation, the whole construct can be considered as correct, if not, then not.

With (106) the calculation only adds up using the approximation $\frac{2}{3}\sqrt{2}$ of (73) for δ, then even exactly. But then α, δ, $\hbar$, G and other values don't fit reality anymore, so that we have to discard this variant unfortunately. Thus, we must find an more exact expression for (105). If possible, only integer fractions, the value π and at most $\sqrt{2}$ should occur therein. After a long trial, days later, I actually succeeded, to find such a relation :

$$m_e = \frac{1}{18\pi^2}\sqrt{2}\,\delta^{-1}m_0Q_0^{-1/3} = 9.10938 \cdot 10^{-31}\,\mathrm{kg} \qquad \Delta = +5.32907 \cdot 10^{-15} \tag{107}$$

For δ we take the current value, for m_0 expression (105). The standard-MachinePrecision is at approx. 10^{-16}. The deviation is a measure for the detuning of the SI-system as a whole, especially caused by the imprecision of G_{2018}, specified with $\pm 2.2 \cdot 10^{-5}$. This way, accuracy can still be improved significantly. Expression (107) exact obviously. That also applies to all other expressions, if we replace $12\pi^2$ by $9\pi^2\sqrt{2}\,\delta$ in them. Now we can determine Q_0 and m_0 even exactly with it. It applies:

$$Q_0 = \left(\frac{1}{18\pi^2}\sqrt{2}\,\delta^{-1}\frac{m_0}{m_e}\right)^3 = 8.34047113224285\cdot 10^{60} \qquad (108)$$

$$m_0 = 9\pi^2\sqrt{2}\,\delta\, m_e Q_0^{1/3} = 2.17643409748237\cdot 10^{-8}\,\mathrm{kg} \qquad (109)$$

Obviously, Q_0 (108) has another value, as determined in [1]. That will be surveyed later on. For m_0 the following relations to other mass quantities turn out:

$$M_H = \hbar H_0/c^2 = m_0 Q_0^{-1} \qquad \text{HUBBLE-mass} \qquad (110)$$

$$m_0 = 9\pi^2\sqrt{2}\,\delta\, m_e Q_0^{1/3} = \hbar\omega_0/c^2 = M_H Q_0 \qquad \text{PLANCK-mass} \qquad (111)$$

$$M_1 = 9\pi^2\sqrt{2}\,\delta\, m_e Q_0^{4/3} = \mu_0\kappa_0\hbar = m_0 Q_0 \qquad \text{MACH-masse} \qquad (112)$$

$$M_2 = 9\pi^2\sqrt{2}\,\delta\, m_e Q_0^{7/3} = \mu_0\kappa_0\hbar_1 = m_0 Q_0^2 \qquad \text{Initial-mass universe} \qquad (113)$$

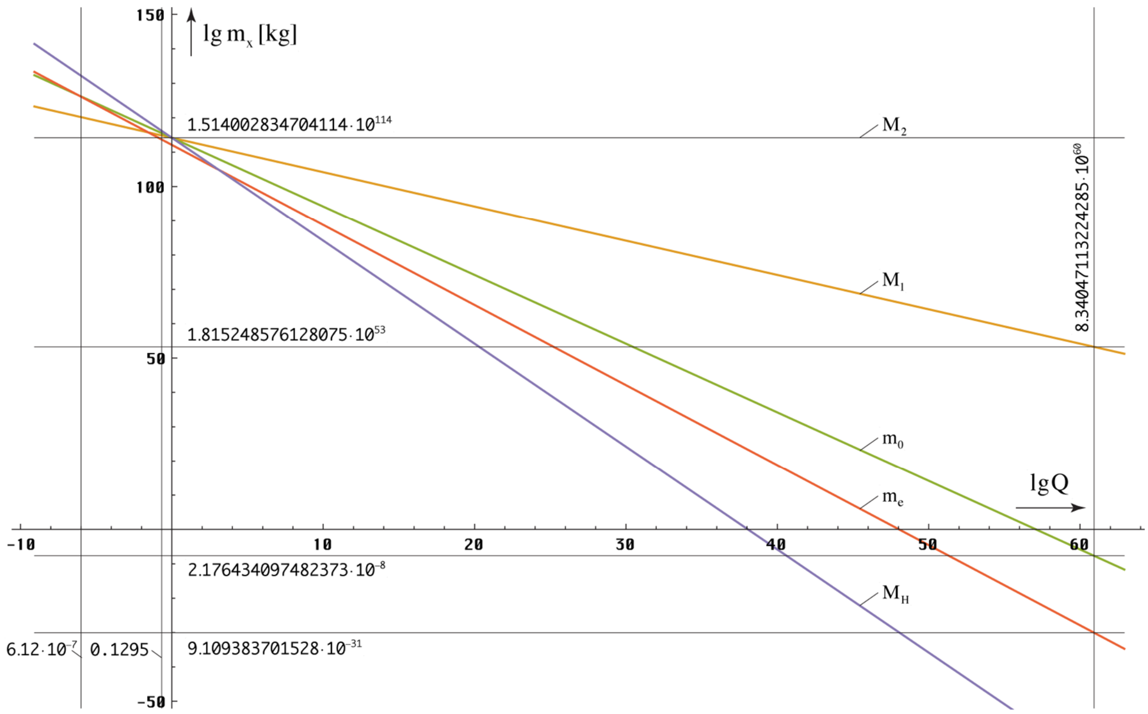

Figure 14
Course of the reference-frame-dependent masses m_x with respect to the phase angle Q, large scale

The course of (110) until (113) for greater values of Q_0 is shown in Figure 14. We can see, all masses except for the electron mass intersect in the point Q=1. M_1, the MACH-mass, is the counter-mass, postulated by MACH, which shall be the reason for the inertial mass of all bodies. According to [1] it's the sum of the masses of the gravitational field (⅔) and of the EM-field (⅓) of the universe, which are mostly concentrated at the particle horizon. It's the red-shifted remnant of the initial mass M_2.

Figure 15 shows the course near Q=1. Even the exact course of the electron mass m_e according to (107) in comparison with m'_e (105) is depicted there.

As we can see, shortly after BB, the so-called HUBBLE-mass M_H, a measure for the rest-mass of the photon, is yet greater than the rest-mass of the electron and not to be neglected. Nowadays the value amounts to $2{,}6094858\cdot 10^{-69}$kg only. The model makes it possible, to simulate the conditions shortly after BB with simple means.

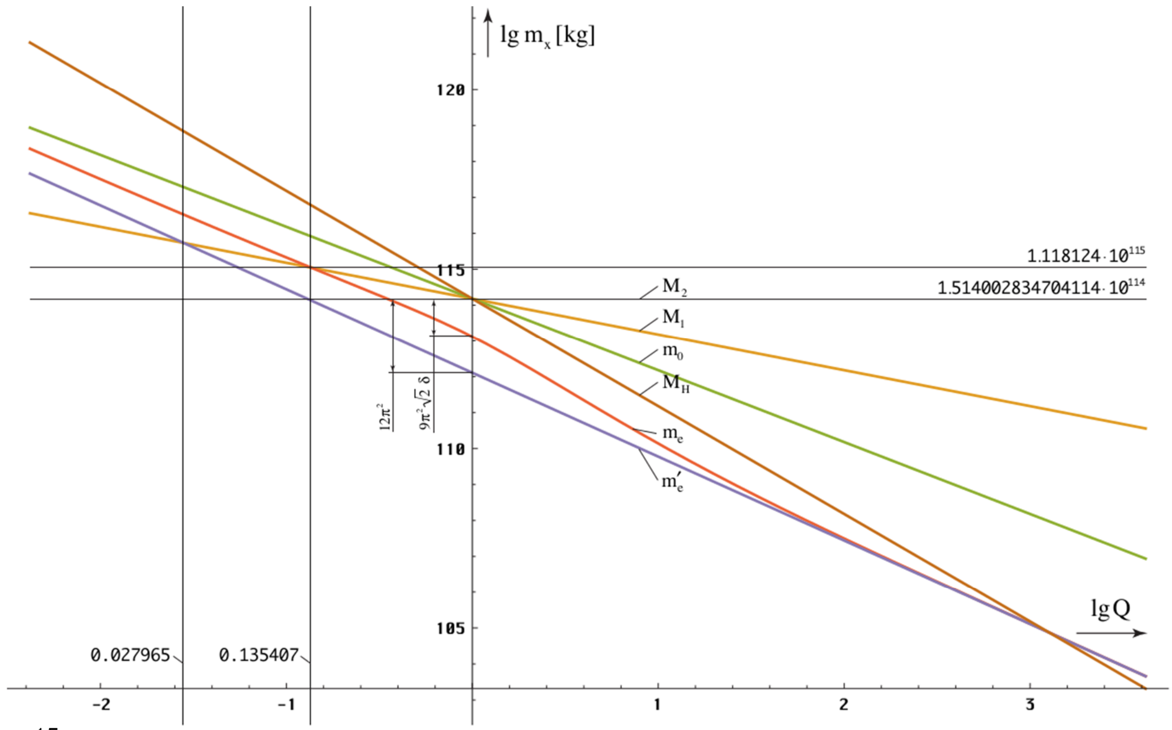

Figure15
Course of the reference-frame-dependent masses m_x with respect to the phase angle Q, small scale

With the CODATA-value of $\hbar$ we are able to determine κ_0 and $\hbar_1$ even now:

$$\kappa_0 = \left(\frac{1}{18\pi^2}\sqrt{2}\right)^3 \delta^{-3} \frac{m_0^4}{m_e^3 \mu_0 \hbar} = 1.3697776631902217 \cdot 10^{93}\,\mathrm{Sm}^{-1} \tag{114}$$

$$\hbar_1 = \hbar Q_0 = 8.795625796565464 \cdot 10^{26}\,\mathrm{Js} \tag{115}$$

Now we can apply these values as initial values (subspace parameters). Then we turn around the calculation direction to top-down. The definition of κ_0 as fixed value also has the advantage, that we don't have to measure it by no means. Due to its extreme size it's also unlikely, that we will be able to carry out such a measurement in the near future. The definition of $\hbar_1$ as fixed value is definitely better, than that of $\hbar$ and even correct. Because of the definition of the Kelvin we also take in addition the BOLTZMANN-constant k as a statistic value and the fixed *genuine* constants are complete. All other stuff is to be calculated. From now on, instead of Q_0 we'll use m_e to the identification of the particular frame of reference, because it can be measured (*magic value*). With it, our *concerted metric system* is ready, and it adds-up, exactly! To the calculation of Q_0 from m_e we still rearrange (108) in the following manner:

$$Q_0 = \left(9\pi^2\sqrt{2}\,\delta \frac{m_e}{\mu_0 \kappa_0 \hbar_1}\right)^{-3/7} \tag{116}$$

In order to transform measured values being subject to the LORENTZ-transformation, we only have to multiply the input parameter with the factor $(Q/\tilde{Q})^{\pm 3/2}$, depending on, whether the LORENTZ-factor γ or γ^{-1} finds use. Furthermore it must be pointed out, that not only $\hbar$, but also m_e varies over the years. With $\hbar$ the variation is at approx. $-1.4036 \cdot 10^{-10}\,a^{-1}$, with m_e at $-2.1054 \cdot 10^{-10}\,a^{-1}$, if only because of the growth of age. That should be taken into account by the SI-panel with the definition of the kg, $\hbar_1$ in contrast is invariable. A definition by means of m_e also would be possible and even recommendable. But the extremely small value is very difficult to scale-up.

3.1.4.2. Dynamic contemplation

After the determination of the static, i.e. time-dependent value of the electron mass, we want to deal with the electron in motion. Because of its smallness it can be accelerated by fields or by collisions with other particles only. Latter one we don't want to contemplate here. Since the electron disposes of the charge e, we conveniently use the electromagnetic field for the acceleration. The whole issue takes place in the vacuum.

3.1.4.2.1. Basics

Although it's about school content of curriculum, I want to go into detail with the basics of acceleration of the electron in the electromagnetic field once again, gathered from [10]. The electrons are released by a heating element at the cathode (0V). By impression of the voltage $+U_b$ at the anode, acceleration takes place. If the anode has a hole, the electrons move-on even behind it with the speed achieved by acceleration. The speed depends on the applied voltage. Nonrelativistically applies: $\frac{1}{2} m_e v^2 = U_b e$. The ray can be focussed by electric or magnetic fields.

With accelerating voltages >2.7kV indeed, the velocity v of the electrons must be treated relativistic, v gains a value >0.1c then. The kinetic energy [J]=[V·As] divided by the electron charge $e = 1.602176634 \cdot 10^{-19}$As the value in eV turns out. The values apply in the observer's frame of reference, we cannot „fly with".

The kinetic energy W_{kin} of an electron equals its total energy W_{re} less the rest energy W_0

$$W_{kin} = m_{rel}c^2 - m_e c^2 \quad (117)$$

The kinetic energy according to the energy-conservation-rule equals the performed acceleration-work of the E-field

$$U_b e = m_{rel}c^2 - m_e c^2 \quad (118)$$

The relativistic mass m_{rel} and the rest mass m_e are linked by the Lorentz factor γ

$$m_{rel} = \gamma m_e = \frac{m_e}{\sqrt{1-\frac{v^2}{c^2}}} = m_e \left(\frac{\tilde{Q}}{Q}\right)^{\frac{3}{2}} \quad (119)$$

Plugging in of the relativistic mass Into the energy equation

$$U_b e = \frac{m_e c^2}{\sqrt{1-\frac{v^2}{c^2}}} - m_e c^2 \quad (120)$$

Out-factoring and division by $m_e c^2$ yields

$$\frac{U_b e}{m_e c^2} = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - 1 = \left(\frac{\tilde{Q}}{Q}\right)^{\frac{3}{2}} - 1 \quad (121)$$

After rearrangement we obtain for $v_{rel}[U_b]$

$$\frac{v}{c} = \sqrt{1-\left(1+\frac{U_b e}{m_e c^2}\right)^{-2}} \quad (122)$$

```
VrelU=Function[ScientificForm[SetPrecision[Sqrt[1-
SetPrecision[1/(1+# qe/me/c^2)^2,180]],180],180]];
```
(123)

In (123) and the subsequent functions the precision is set like that, we can calculate even velocities with e.g. 0,999999'[180]. For the difference $1 - v_{rel}[U_b]$ the function DVrelU (124) can be used.

```
DVrelU=Function[ScientificForm[SetPrecision[1-(Sqrt[1-
SetPrecision[1/(1+# qe/me/c^2)^2,180]]),180],10]];
```
(124)

With the help of (121) we can calculate the phase angle $Q_{rel}[U_b]$, once relative to $\tilde{Q}_0$, the other time absolutely (*italic*). Please don't change the fraction $1/(\ldots)^{2/3}$ into $(\ldots)^{-2/3}$, otherwise you will get an error message *Division by zero!* with particular values.

$$Q_0 = \tilde{Q}_0 \left(1+\frac{U_b e}{m_e c^2}\right)^{-\frac{2}{3}} \qquad (125)$$

```
QrelU=Function[SetPrecision[SetPrecision[1/(1+# qe/me/c^2)^(2/3),180],16]];
QQrelU=Function[Q0*(QrelU[#])];
```
(126)

Also important is the inverse function of (123) UeV, calculating the necessary acceleration-voltage for a particular (v/c). It also yields the kinetic energy in [eV] at the same time.

$$U_b = \frac{m_e c^2}{e}\left(\left[1-\frac{v^2}{c^2}\right]^{-\frac{1}{2}}-1\right) \qquad (127)$$

```
UeU=Function[a4711=SetPrecision[#,1000]; (me c^2(1/Sqrt[1-a4711^2]-1))/qe];
```
(128)

3.1.4.2.2. Energetic contemplation

Shortly after the start of operation of the Large Hadron Collider (LHC) at CERN could be read in the press, that it „simulated the BB“ [9]. Thus, we want to verify at this point, if it is possible at all. The prior condition would be, to reach the nonlinear range at a phase angle of $Q_0 < 10^3$. That would be in the temporal close-up range of the phase jump near $Q_0=1$ approx. 10^{-90}s after BB (Figure 13).

Just let's try, to accelerate an electron onto such a velocity. What energy we would need for it? To the calculation we use the functions vQ0 (103) and UeV (128). It's a good idea, to suppress the intermediate result of vQ0, otherwise you will get a multiline output with 173 nines after the decimal point in the form of $9.99\ldots9913822\cdot10^{-1}$. So we enter the following: UeV[vQ0[10^3]] obtaining a value of $3.8923\cdot10^{92}$eV. But the LHC has approx. 13TeV only, that's $1.3\cdot10^{13}$eV. Even if the LHC works with protons, energy is energy, thus we are orders of magnitude below that.

Value	Name	$m_x=W_x e/c^2$ [kg]	$W_x=m_x c^2/e$ [eV]	Q_0 [1]	
M_2	Initial-mass univ	$1.514002834704\cdot10^{114}$	$1.23085\cdot10^{97}$	$1.00000\cdot10^{0}$	
B_L	Linearity border	$6.938648236086\cdot10^{56}$	$3.89230\cdot10^{92}$	$1.00000\cdot10^{3}$	
M_1	Mach-mass	$1.815248576128\cdot10^{53}$	$1.01828\cdot10^{89}$	$2.44470\cdot10^{5}$	
U_1	Mach-voltage	$1.550667802897\cdot10^{52}$	$8.69861\cdot10^{87}$	$1.26039\cdot10^{6}$	
m_0	Planck-mass	$2.176434097482\cdot10^{-8}$	$1.22089\cdot10^{28}$	$1.00543\cdot10^{46}$	
U_0	Planck-voltage	$1.859208884401\cdot10^{-9}$	$1.04294\cdot10^{27}$	$5.18360\cdot10^{46}$	
m_e	Electron-mass	$9.109383701528\cdot10^{-31}$	$5.10998\cdot10^{5}$	$5.25417\cdot10^{60}$	
M_H	Hubble-mass	$2.609485798792\cdot10^{-69}$	$1.4638\cdot10^{-33}$	$8.34047\cdot10^{60}$	← Q_0

Table 1
Energy and masses in the Universe

The interesting question is, whether it is even possible, to reach such a high speed, especially for the financiers. For this purpose, I compiled the masses and their energy $m_x c^2/e$ in eV in comparison with the corresponding phase angle Q_0, determined in (110) until (113) in table 1.

As we can see, the necessary $3.8923 \cdot 10^{92}$eV is above the MACH-mass. So there is no longer enough energy in the universe, in order to accelerate one single electron into the nonlinear range $Q_0 < 10^3$. As already specified, M_1 equals the sum of the gravitational and of the electromagnetic field of the universe.

As stated in [6] the density is at $\frac{3}{2}G_{11}(R/2) = 1.94676 \cdot 10^{-29}$ kg·dm^{-3}. But how about the masses, galaxies, stars, planets, dust etc.? So the mass-density is about two orders of magnitude below at $1.845 \cdot 10^{-31}$ kg·dm^{-3}. That's much less. Furthermore, the required acceleration-voltage is greater than U_0 (PLANCK) and U_1 (MACH). According to [11] these are defined in the following manner:

$$U_0 = \sqrt{\frac{c^4}{4\pi\varepsilon_0 G_{(0)}}} \qquad U_1 = \sqrt{\frac{c^4}{4\pi\varepsilon_0 G_1}} \qquad U_2 = \sqrt{\frac{c^4}{4\pi\varepsilon_0 G_2}} \tag{129}$$

Because of the existence of m_0, M_1 and M_2 there are also three different values for the gravitational constant:

$$G = c^2 r_0 / m_0 \qquad G_1 = c^2 r_1 / M_1 = G Q_0^{-2} \qquad G_2 = c^2 r_1 / M_2 = G Q_0^{-3} \tag{130}$$

U_2 and G_2 are legacy values at this point, impossible nowadays. Thus, more than U_1 won't work. Presuming U_1 as the highest possible voltage, if technically feasible at all, with the maximum available energy $M_1 c^2$, almost 12 electrons can be accelerated to a top speed below the linearity border. Maybe it even suffices for one proton. So much for „simulating BB".

In Figure 16-18 the theoretical courses of the phase angle Q_0, of the electron charge e and of α as a function of the kinetic energy as well as of the acceleration-voltage are shown once again. Additionally, the energetic boundaries from table 1 are marked. As we can see, we can't even get close to the BB.

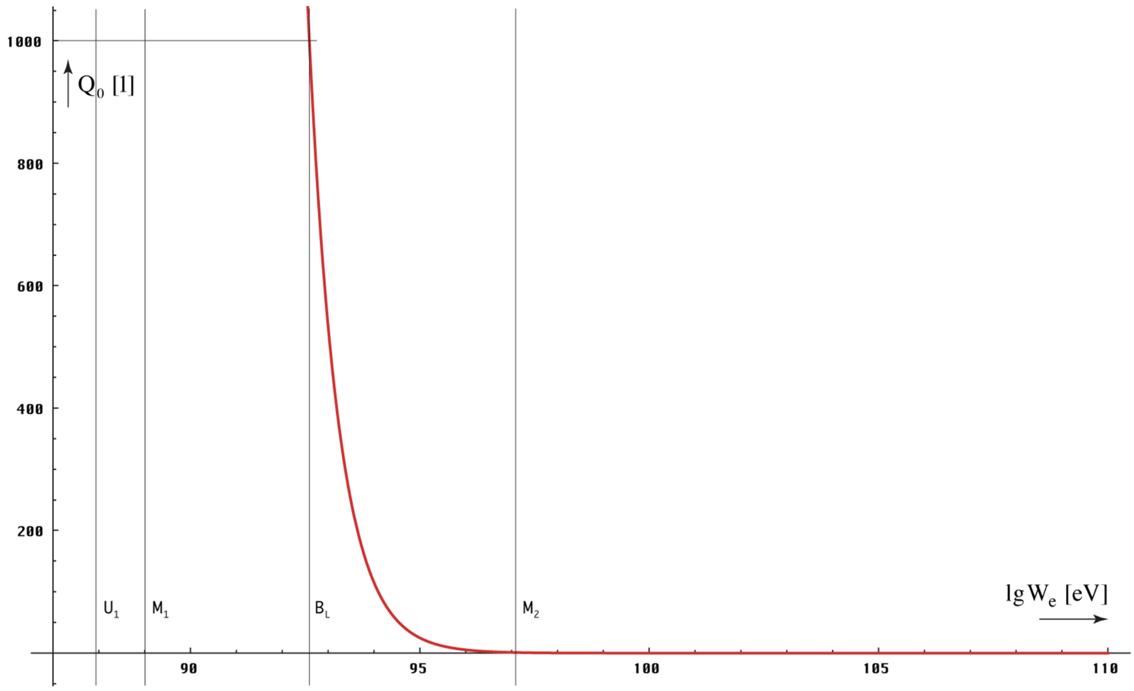

Figure 16
Phase angle Q_0 as a function
of the energy of the electron

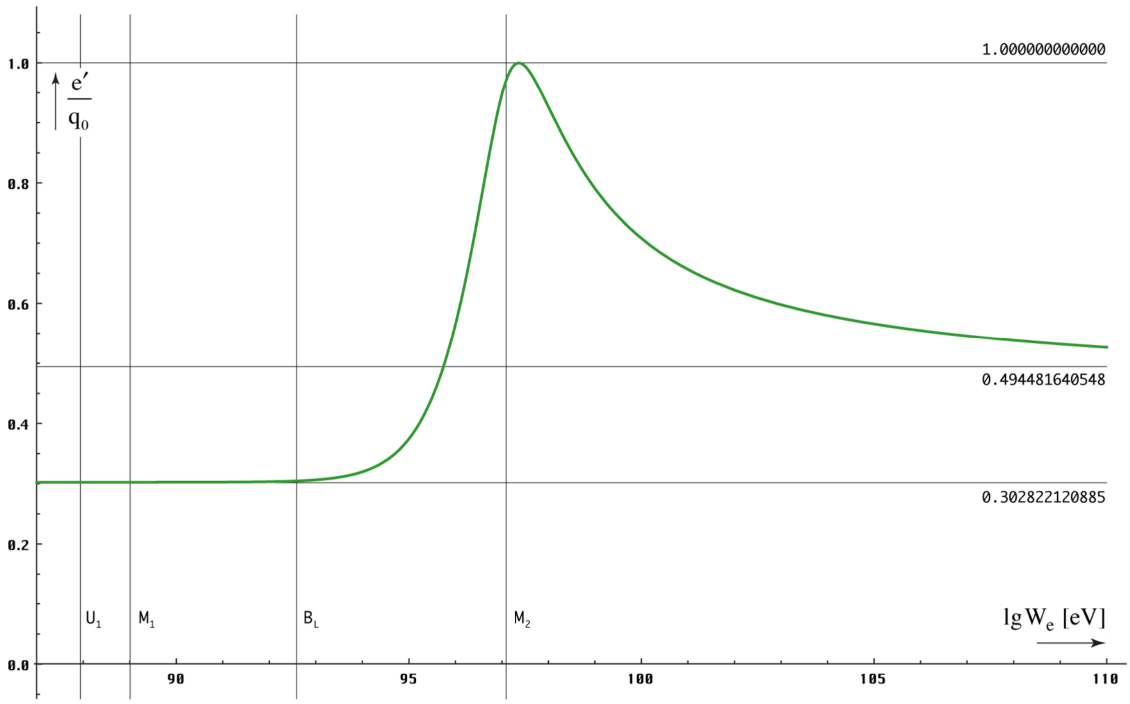

Figure 17
Ratio of the electron- to the PLANCK-charge
as a function of the energy of the electron

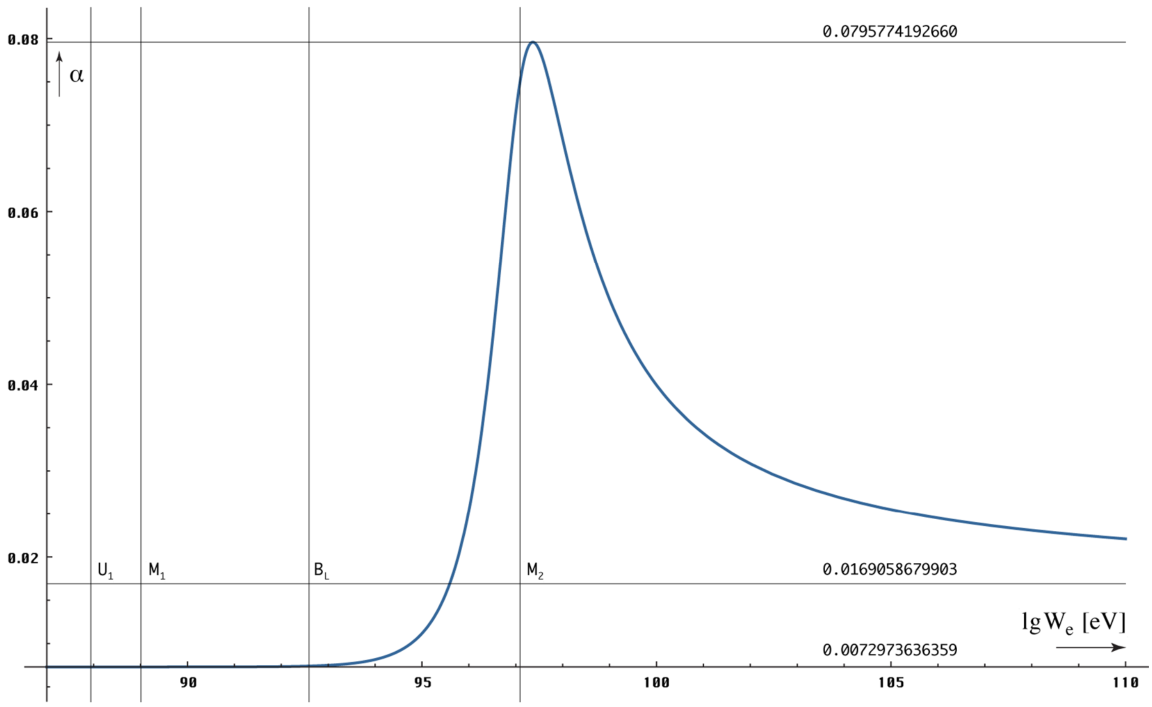

Figure 18
Correction factor α as a function
of the energy of the electron

Finally, on the subject of particle accelerator. I had promised, to address this point again with respect to the additional share of the mass- and charge-increase. The question is, do the additional shares cancel each other even in a particle accelerator? Just let's recall the various dependencies:

$$mc^2 \sim Q_0^{-\frac{5}{2}} \qquad \hbar\omega \sim Q_0^{-\frac{5}{2}} \tag{131}$$

$$\omega \sim Q_0^{-\frac{3}{2}} \qquad \hbar = q_0\varphi_0 \sim Q_0^{-\frac{2}{2}} \quad \rightarrow \quad q_0 \sim Q_0^{-\frac{1}{2}} \quad \varphi_0 \sim Q_0^{-\frac{1}{2}} \tag{132}$$

For the technically accessible domain suffice the approximation formulae. It is currently generally assumed, that both, the electron charge and PLANCKs quantity of action are genuine constants. The same applies even to the magnetic induction $B=d\varphi/dA$, with which the electron is kept on track in the accelerator.

Here we have to do with two types of forces. On the one hand, the electron is subject to the centrifugal force $F_Z=m_e v/r$, on the other hand it generates a LORENTZ-force $\mathbf{F_L}=e(\mathbf{v}\times\mathbf{B})$. Both are directed against each other. It applies $v\perp r$, thus $F_L=e\,vB$. With it, we obtain the classical expression for the cyclotron ($B=$const) and even for the synchrotron ($B\neq$const):

$$r = \frac{\beta(\tilde{m}_e v)}{eB} \sim \beta v \qquad \text{with} \qquad \beta = \gamma^{-1} = \sqrt{1-\frac{v^2}{c^2}} \tag{133}$$

Now, according to this model as well m_e, e as the induction B are subject to an additional redshift. Shouldn't this be found out somehow in accelerator-experiments? Altogether applies to the electron mass $m_e\sim Q_0^{-5/2}\sim\beta^{5/3}$, to the electron charge $e\sim Q_0^{-1/2}\sim\beta^{1/3}$. If we assume, that the track-radius r and with it, also the elements of area dA of the magnetic field B are *not* subject to a length contraction for the observer, applies to the induction $B\sim\varphi\sim Q_0^{-1/2}\sim\beta^{1/3}$. Thus, plugged into (133) we just obtain

$$r = \frac{\beta^{5/3}(\tilde{m}_e v)}{\beta^{1/3}\tilde{e}\,\beta^{1/3}\tilde{B}} \sim \beta v \tag{134}$$

The same result as with the classical model, where we assumed e and B to be constant. Thus, the additional mass-increase really cancels out.

3.1.4.2.3. Perspective

Before we engage in further characteristics of the electron, I want to answer the following question: Since it already needs an extreme amount of energy in order to accelerate one single electron to a speed within spitting distance to c, is it even possible, to get a macroscopic body up to a similar speed? It's basically a question of whether we'll ever be able to travel to other stars with a space-craft.

The answer is „Yes“. In addition to the acceleration of a particle/body in a field, the so-called external acceleration there is namely a second kind of acceleration, the internal or self-acceleration. That is, if the body disposes of its own drive. Then very different relations apply.

In principle, a body with the rest mass m_0 contains exactly as much energy (m_0c^2), in order to completely accelerate it to light speed. Let's take a space-craft with photon-drive as an example. The energy shall be generated by matter-antimatter-annihilation and propulsion (mirror) shall work with 100% efficiency. Since it's about a rocket, in principle the ZIOLKOWSKI-equation applies. But there is a difference because of the constancy of light speed, so that we can work with the same ansatz indeed, but finally a different relation turns out. According to [12] the ZIOLKOWSKI-equation for $v_0=0$ reads as follows:

$$v = -v_g \ln\left(1-\frac{bt}{m_0}\right) \qquad \begin{array}{llll} v_g = c & \text{Specific momentum drive} & b = \dot{m} & \text{Fuel consumption} \\ F = v_g\cdot b = P/c & \text{Thrust} & m_0 = m_L + m_T & \text{Rest mass} \end{array} \tag{135}$$

m_L is the empty weight, m_T tank filling. As we can see, F only depends on the power P, unlike as with a normal rocket. Thus, (135) doesn't apply. Therefore, we start with the ansatz in [12] . I cite:

»We split the whole continuously proceeding acceleration process into such small steps, so that step by step, a particular value of the current speed of rocket can be assigned to v and also its mass to the value m. In the current barycentric system of the rocket the mass Δm is thrusted out with the speed v_g, it has the momentum $v_g \Delta m$ therefore. Because of the conservation of momentum the rocket gets a repulsion momentum of the same size $m \Delta v$, increasing speed in the opposite direction about Δv. After the following limiting process up to even more, even smaller steps it no longer plays a role, that we should schedule $m - \Delta m$ instead of the mass m to be correct. Hereby, the changings Δm and Δv become the differentials dm as well as dv. Thus, it yields (using the minus sign because v grows while m drops)«.

$$v_g dm = -m\,dv \qquad dm = \frac{P}{c^2}dt \qquad dv = -\frac{c}{m_0}dm \tag{136}$$

$$dv = -\cancel{c}\frac{P}{m_0 c^{\cancel{2}}}dt \qquad v = -\frac{1}{m_0 c}\int P\,dt \tag{137}$$

The whole issue is simply considered, without sophistries like acceleration, distance, travel duration, payload, relativistic effects etc. If you are interested, please read [13]. Only the conclusion from (137) is of interest. In principle it's possible, to achieve light speed with a space-craft. You just have to „burn" the complete ship, cargo, the passengers, the crew, the drive and all the rest for that purpose. Then you really move with c, but only in the form of a light ray. You can also push the self-destruction-button instead. A reasonable navigation is possible. As a problem remains the fuel. Antimatter with a negative mass would be very advantageous in this connection.

3.1.5. The classical electron radius

Meanwhile we know, that it doesn't actually exist, since the electron is described by a wave function. But the electron disposes of particle-properties too. Furthermore, the value still occurs in particular expressions, amongst others in δ, which are still useful nowadays. Moreover, we defined the line element (MLE) as a ball capacitor, moving in its own magnetic field. Also we had assigned a radius $r_0/(4\pi)$ to this, which shows similarities with the practice for the definition of the classical electron radius.

In doing so, it was assumed, that even the electron resembles a ball capacitor with a specific capacity depending on the electron-radius. Because the charge was known, only one particular radius comes into consideration, with which energy, charge and capacity fit each other. It is defined as follows:

$$r_e = \frac{e^2}{4\pi\varepsilon_0 m_e c^2} \tag{138}$$

Since it's about a length, the relations to the PLANCK-units, mainly to r_0, are really important. Now, we have already used this value in (890 [1]) to the determination of Q_0, but we got a different result. Aside from that, the value determined with (116) seems to be more exact, as a comparison with the CMBR-temperature, measured by the COBE-satellite, suggests. See section 3.2. for more details. Thus, it's appropriate, to impose expression (890 [1]) with a correction factor ζ, in order to obtain the result of (116). If there is already a curvature with the surface-calculation, we can assume, that even the radius is bent. Maybe, we even obtain the desired relation r_e/r_0 then. Equating (116) with (890 [1]) with a subsequent substitution by (138), with the help of (82) and (104) we obtain:

$$Q_0 = \left(9\pi^2\sqrt{2}\,\delta\frac{m_e}{\mu_0\kappa_0\hbar_1}\right)^{-3/7} = \frac{3}{2}\left(\frac{\zeta r_e}{r_0}\right)^3 \tag{139}$$

$$\zeta = \sqrt[3]{\frac{2}{3}}\frac{r_0}{r_e}\left(9\pi^2\sqrt{2}\,\delta\frac{m_e}{\mu_0\kappa_0\hbar_1}\right)^{-1/7} \tag{140}$$

$$\zeta = \frac{1}{9\pi^2}\frac{1}{\sqrt[3]{3\sqrt{2}\alpha\delta}} = \frac{1}{36\pi^3}\frac{1}{\sqrt[3]{3\sqrt{2}}}\frac{m_p}{m_e} = 1.016119033114739 = \text{const} \tag{141}$$

The ratio m_p/m_e is known to be constant. If the curvature were based on the same curve as in Figure 10, ζ would match the value $Q_0=0.748612\approx 3/4$. Now we can also specify the relations to the other PLANCK-lengths:

$$r_1 = \frac{1}{\kappa_0 Z_0} \tag{142}$$

$$r_e = \sqrt[3]{\tfrac{2}{3}}\, r_0\zeta^{-1}Q_0^{1/3} = \sqrt[3]{\tfrac{2}{3}}\, r_1\zeta^{-1}Q_0^{4/3} \tag{143}$$

$$r_0 = \sqrt[3]{\tfrac{3}{2}}\, r_e\zeta Q_0^{-1/3} = r_1 Q_0 = \frac{c}{\omega_0} \tag{144}$$

$$R = \sqrt[3]{\tfrac{3}{2}}\, r_e\zeta Q_0^{2/3} = r_1 Q_0^2 = 2cT \tag{145}$$

r_e is greater than r_0. The result is exact. Now, even the right-hand expression of (139) yields the correct value. Still remain (840 [6]) und (841 [6]), including ζ once again:

$$\kappa_0 = \frac{3}{8}\frac{\zeta^3 e^6 c}{16\pi^3\varepsilon_0^2 G^2\hbar^2 m_e^3} = (144\pi^4\sqrt{2})^{-3}\frac{c\,e^6 m_p^3}{(\varepsilon_0 G\hbar m_e^3)^2} = 1.36977766319\cdot 10^{93}\,\text{Sm}^{-1} \tag{841 [6]}$$

$$H_0 = \frac{2}{3}\frac{64\pi^3\varepsilon_0 G\hbar m_e^3}{\zeta^3\mu_0^2 e^6} = (144\pi^4\sqrt{2})^3\frac{G\hbar c^4\varepsilon_0^3 m_e^6}{e^6 m_p^3} = 2.2239252345813\cdot 10^{-18}\,\text{s}^{-1} \tag{840 [6]}$$

In this context, the last expression should be presented once again in $\text{kms}^{-1}\text{Mpc}^{-1}$ with ζ (=1.016119033114739) and without ζ (=1).

$$H_0 = \frac{\omega_0}{Q_0} = \frac{2}{3}\frac{64\pi^3\varepsilon_0 G\hbar m_e^3}{\zeta^3\mu_0^2 e^6} = \begin{cases} 2.447866\cdot 10^{-18}\,\text{s}^{-1} = 71.9963\,\text{kms}^{-1}\text{Mpc}^{-1} \\ 2.223925\cdot 10^{-18}\,\text{s}^{-1} = 68.6241\,\text{kms}^{-1}\text{Mpc}^{-1}\ \text{with}\ \zeta \end{cases} \tag{1051 [6]}$$

Obviously ζ not only seems to be a correction factor for Q_0, based on the curvature of the electron radius (139), but also to the conversion of the two different H_0 values, which arise from astronomical observations and from CMBR considerations.

Now let's have a look, if and which reference-frame-dependent variations cancel each other. At first the classical expression. I used the relativistic stretch factor β for the mass:

$$r_e = \frac{e^2}{4\pi\varepsilon_0\beta\tilde{m}_e c^2} \sim \beta^{-1} \tag{146}$$

With it, the classical electron radius according to the classical understanding (interesting pairing) follows the relativistic length-contraction, which is not a contradiction. Now we apply the real values for mass and charge of the electron obtaining the expression for the „modern" classical electron radius:

$$r_e = \frac{\beta^{2/3}\tilde{e}^2}{4\pi\varepsilon_0\beta^{5/3}\tilde{m}_e c^2} \sim \beta^{-1} \sim Q_0^{3/2} \qquad (147)$$

The additional mass- and charge-increase cancel each other even here. Also according to a „modern" view the radius is subject to the single relativistic length-contraction. With it, there is an essential difference to the capacitor of the MLE, whose radius is proportional Q_0 only.

The fact, that most of the changes cancel each other, suggests the physical laws to be the same in all reference-frames. But that's only partially correct. Just the references to the subspace-values are changing. Fortunately, these of all are the ones, which finally cancel out. Only the LORENTZ-share remains. That means, we have to do it with a *virtual relativity principle*. The laws of physics only *appear* to be the same always and everywhere. The version advocated by EINSTEIN applies nevertheless:

> *„Die Gesetze, nach denen sich die Zustände der physikalischen Systeme ändern, sind unabhängig davon, auf welches von zwei relativ zueinander in gleichförmiger Translationsbewegung befindlichen Koordinatensystemen diese Zustandsänderungen bezogen werden."[14]*

The subspace itself is known, not to be a reference-frame. There is no preferred frame of reference. No problem, the SRT would correctly do the job even then. But there is something like a superordinate system for the cosmos as a whole. Besides it's not certain, that our value Q_0 represents the maximum. Possibly there are even others with a higher Q_0.

The question, „Where is the maximum?", is hard to be answered, maybe in that we calculate out the relative speed with respect to the microwave background. According to [15] the value amounts to 368±2 km/s. With the help of (101) it should be possible to calculate Q_{max}. We rearrange:

$$Q_{max} = Q_0\left[1-\frac{v^2}{c^2}\right]^{-1/3} = 8.340471132\cdot 10^{60}(1-(3.68\cdot 10^5 ms^{-1}c^{-1})^2)^{-1/3} = 8.340475321\cdot 10^{60} \qquad (148)$$

As we can see, the difference is not that big. The deviation amounts to $+5.02\cdot 10^{-7}$. That makes a difference in the age of +14310 years only.

3.1.6. BOHR's hydrogen-radius

Once again a length, which really doesn't exist, which may serve as a rule, if the proportions inside the atom change or not. According to [16] it is defined as follows:

$$a_0 = \frac{4\pi\varepsilon_0\hbar^2}{m_e e^2} = 5.291772105440824\cdot 10^{-11} m \qquad \Delta = -6.798\cdot 10^{-10} \qquad (149)$$

Δ indicates the deviation to the measuring value and is tightly above the measuring inaccuracy. With the help of (82), (107) and (111) we acquire the relations to the PLANCK-lengths:

$$a_0 = 9\pi^2\sqrt{2}\alpha^{-1}\delta r_1 Q_0^{4/3} = 576\pi^5\sqrt{2}\frac{m_e}{m_p} r_1 Q_0^{4/3}\operatorname{cosec}^4\gamma \qquad (150)$$

$$a_0 = 9\pi^2\sqrt{2}\alpha^{-1}\delta r_0 Q_0^{1/3} = 576\pi^5\sqrt{2}\frac{m_e}{m_p} r_0 Q_0^{1/3}\operatorname{cosec}^4\gamma \qquad (151)$$

As well α (proton), as even δ (electron) are applied in this connection. It should also be noted, that m_e behaves differently shortly after BB, and that according to (107). But according to previous understanding, hydrogen atoms do not exist at all at this time. Since even the angle γ is involved, it however could not be true. Now let's see again, if and which reference-frame-dependent changes cancel out:

$$a_0 \;=\; \frac{4\pi\varepsilon_0\hbar^2}{\beta\tilde{m}_e e^2} \;\sim\; \beta^{-1} \tag{152}$$

BOHR's hydrogen-radius is also subject to the single relativistic length-contraction, i.e. the atomic scales are observed shortened by β^{-1}, just like a macroscopic body. But what about the additional shares?

$$a_0 \;=\; \frac{4\pi\varepsilon_0\beta^{4/3}\tilde{\hbar}^2}{\beta^{5/3}\tilde{m}_e\beta^{2/3}\tilde{e}^2} \;\sim\; \beta^{-1} \sim Q_0^{3/2} \tag{153}$$

The additional shares cancel each other even here. That means, as well the dimensions of particles, as even the „track-radii", i.e. the dimensions of orbitals, are subject to the single relativistic length-contraction only. Otherwise the atoms would have been different chemical properties at an early point of time of the evolution of the universe.

3.1.7. The COMPTON-wave-length of the electron/proton/neutron...

The COMPTON-wavelength is a characteristic size for a particle with mass. It specifies the increase of wavelength of a photon rectangularly scattered on it [17]. As a representative we only consider the electron and the so-called reduced COMPTON-wavelength $\lambda\!\!\!^{-}_C(\hbar)$. According to [17] is $\lambda\!\!\!^{-}_C = \lambda\!\!\!^{-}_{C,e}$ defined as follows:

$$\lambda\!\!\!^{-}_C \;=\; \frac{\hbar}{m_e c} \;=\; 3.8615926772447883\cdot 10^{-13}\,\mathrm{m} \qquad \Delta = -6.13\cdot 10^{-10} \tag{154}$$

By application of (107) and (111) we acquire the relation to the PLANCK-lengths again:

$$\lambda\!\!\!^{-}_C \;=\; 9\pi^2\sqrt{2}\,\delta r_0 Q_0^{1/3} = 9\pi^2\sqrt{2}\,\delta r_1 Q_0^{4/3} \tag{155}$$

Altogether quite simple expressions, reflecting the „mechanism" behind in principle. Also they are related to the invariables of subspace and with it, even better than the relations, in which other natural "constants" are related to each other, without knowing, if and how they are changing. But to the determination, how the additional relativistic shares cancel out, we make use of (154):

$$\lambda\!\!\!^{-}_C \;=\; \frac{\hbar}{\beta\tilde{m}_e c} \;\sim\; \beta^{-1} \tag{156}$$

$$\lambda\!\!\!^{-}_C \;=\; \frac{\beta^{2/3}\tilde{\hbar}}{\beta^{5/3}\tilde{m}_e c} \;\sim\; \beta^{-1} \;\sim\; Q_0^{3/2} \tag{157}$$

The shares cancel each other even here. But the exact expression should read different in fact, since it's about a (space-like) wave-function. This is considered by (155).

3.1.8. The RYDBERG-constant

The RYDBERG-constant R_∞ natural constant named after Johannes RYDBERG. It occurs in the RYDBERG-formula, an approximation to the calculation of atomic spectra. Its value is the ionisation energy of the hydrogen atom, expressed as wave-count neglecting relativistic effects and the co-movement of the nucleus, thus with infinite nuclear mass, that's why the index ∞ (citation [18]). Under application of the reduced value $\lambda\!\!\!^{-}_C(\hbar)=\lambda\!\!\!^{-}_{C,e}=\lambda\!\!\!^{-}_C$ and of $\hbar$ instead of h, determined in the previous section, we have to rewrite the definition in [18] in the following manner:

$$R_\infty = \frac{1}{4\pi}\frac{\alpha^2}{\lambda\!\!\!^{-}_C} = \frac{m_e e^4}{64\pi^3\varepsilon_0^2\hbar^3} = \frac{\alpha}{4\pi a_0} = 1.0973731568160\cdot 10^7 \mathrm{m}^{-1} \quad \Delta = \pm 1.9\cdot 10^{-12} \tag{158}$$

Shown is the measuring value at this point. The first expression is best suited, to establish the references to the PLANCK-units with the help of (155):

$$R_\infty = \frac{1}{72\pi^3}\sqrt{2}\alpha^2\delta^{-1}r_1^{-1}Q_0^{-4/3} = \frac{1}{18432\pi^7}\sqrt{2}\frac{m_P}{m_e}r_1^{-1}Q_0^{-4/3}\sin^6\gamma \tag{159}$$

$$R_\infty = \frac{1}{72\pi^3}\sqrt{2}\alpha^2\delta^{-1}r_0^{-1}Q_0^{-1/3} = \frac{1}{18432\pi^7}\sqrt{2}\frac{m_P}{m_e}r_0^{-1}Q_0^{-1/3}\sin^6\gamma \tag{160}$$

Obviously, the RYDBERG-constant is no constant at all. Since it's about the natural constant most exactly measured of all, it's also best suited to determine the detuning of the SI-system. The deviation of (159) to the measured value (158) namely amounts to $7.44431\cdot 10^{-10}$. That's much more than the measuring inaccuracy in the size of $1.9\cdot 10^{-12}$. The calculated value amounts to $1.097373157632939\cdot 10^7 \mathrm{m}^{-1}$.

This example shows, that the SI-system in its present configuration is reaching its limits. A further increase of exactness is impossible without considering the reference frame and the relations of the natural constants among themselves. This way, even the outliers can be identified much better. Using the value $m_e/m_P=5.44617021487(33)\cdot 10^{-4}$ specified in CODATA$_{2018}$ instead of the genuine quotient and re-determining Q_0, κ_0 and $\hbar_1$ thereafter, the accuracy decreases by up to 3 orders of magnitude. That's also a weak point. The ratio m_e/m_P is something like a second magic value or an important side-condition. Since it's considered to be constant, one could theoretically define it as a fixed value. But I think, that's not a good idea. With a reconfiguration even R_∞ instead of m_e would be suitable as a magic value.

Often used is also the RYDBERG-frequency $R=cR_\infty=3.2898419603\cdot 10^{15}$Hz. To the comparison with ω_0 and ω_1 we still calculate the related angular frequency $\omega_R=2\pi cR_\infty$ with the amount $2.0670686668\cdot 10^{16}\mathrm{s}^{-1}$. It applies:

$$\omega_1 = \frac{\kappa_0}{\varepsilon_0} = \frac{1}{2t_1} \tag{6}$$

$$\omega_0 = 18\pi^2\sqrt{2}\alpha^{-2}\delta\omega_R Q_0^{1/3} = 4608\pi^6\sqrt{2}\frac{m_e}{m_P}\omega_R Q_0^{1/3}\sin^6\gamma = \omega_1 Q_0^{-1} = \frac{1}{2t_0} \tag{161}$$

$$\omega_R = \frac{1}{36\pi^2}\sqrt{2}\alpha^2\delta^{-1}\omega_1 Q_0^{-4/3} = \frac{1}{9216\pi^6}\sqrt{2}\frac{m_P}{m_e}\omega_1 Q_0^{-4/3}\sin^6\gamma = 2\pi c R_\infty \tag{162}$$

$$H_0 = 18\pi^2\sqrt{2}\alpha^{-2}\delta\omega_R Q_0^{-2/3} = 4608\pi^6\sqrt{2}\frac{m_e}{m_P}\omega_R Q_0^{-2/3}\sin^6\gamma = \omega_1 Q_0^{-2} = \frac{1}{2T} \tag{163}$$

By character, the HUBBLE-parameter H_0 is an angular frequency too, see also section 3.3.2.3. Because of the definition in (158) it's easy to verify the behaviour of the reference-frame-dependent sizes. As well classically, as even recently, everything cancels out again:

$$R_\infty = \frac{1}{4\pi}\frac{\alpha^2}{\lambda\!\!\!^{-}_C} \sim \beta \sim Q_0^{-3/2} \qquad \omega_R = 2\pi c R_\infty \sim \beta \sim Q_0^{-3/2} \tag{164}$$

3.1.9. BOHR's magneton/nuclear magneton

According to [20] in quantum mechanical view the track angular momentum $\vec{\mathbf{L}}$of a charged point particle with the mass m and the charge q generates the magnetic moment (165)

$$\vec{\mu} = \mu\frac{\vec{\mathbf{L}}}{\hbar} \tag{165}$$

$$\mu = \frac{q}{2m}\hbar \tag{166}$$

Then, expression (166) is the magneton μ of the particle. BOHR's magneton μ_B is the magnetic dipole moment of the electron, the nuclear magneton μ_N the magnetic dipole moment of the proton. Both only differ in the mass (m_e resp. m_p) in the denominator. We only regard the electron at this point. According to [20] μ_B is defined as follows:

$$\mu_B = \frac{e\hbar}{2m_e} = -9.274010078328\cdot 10^{-24}\,\mathrm{JT}^{-1} \qquad \Delta = \pm 3\cdot 10^{-10} \tag{167}$$

It should be noted, that the magnetic moment $\vec{\mathbf{L}}$ of the electron is always directed opposite to its track angular momentum due to the negative charge, hence the negative sign [20]. Now let's look for the relations to the PLANCK-units. With the help of (107) and of (21[1]) $m_0=\mu_0 q_0^2 r_0$ we substitute e and m_e by q_0 and m_0. We get:

$$\mu_B = -\frac{9}{2}\pi^2\sqrt{\frac{2\hbar_1}{Z_0}}\,\frac{\delta\sin\gamma}{\mu_0\kappa_0}\,Q_0^{5/6} = -9.2740100726513\cdot 10^{-24}\,\mathrm{JT}^{-1} \qquad \Delta = -6.12\cdot 10^{-10} \tag{168}$$

Here, the deviation of the measured to the calculated value is twice as big, as the given measuring accuracy. Obviously, inaccuracies of other measurands have been passed through here. Also it's strange, that all values specified in this section are having the same inaccuracy of $\pm 3\cdot 10^{-10}$. The expressions relating the PLANCK-units all are rechecked and yield the same result as the original definition, in that case (167). Latter one a deviation to the measuring value same as (168) turns out. There, probably something else is jinxed.

A comparison with other PLANCK-units of the same kind is impossible in this case. Still, the behaviour of the reference-frame-dependent values remains. Starting with (167) according to the classical view, applies:

$$\mu_B = \frac{e\hbar}{2\beta\tilde{m}_e} \sim \beta^{-1} \tag{169}$$

Inserting the additional shares we obtain:

$$\mu_B = \frac{\beta^{1/3}\tilde{e}\beta^{2/3}\hbar}{2\beta^{5/3}\tilde{m}_e} \sim \beta^{-2/3} \sim Q_0 \tag{170}$$

In this case we get a different result. But since the magnetic moment always appears in connection with a charge or a magnetic flux, which both are proportional $\beta^{-1/3}$, there is a cancellation of the additional shares too. All in all we can say, the spatial share of total redshift does not take any effect to the physical laws at the observer, neither qualitative nor quantitative. It only has a cosmologic meaning and plays an important role with the creation of a gravitational theory.

With it, we analyzed most of the values associated with the electron. Of course, there is a lot of further possible candidates. I want to leave them over for the reader. I pointed the way to add new values. Doing so always must be substituted in such a manner, that the relation depend on Q_0 and/or invariants only. As next I want to have a look at some other values, which surprisingly also can be calculated with the concerted system.

3.2. The CMBR-temperature

Some readers will probably be surprised, to find this value of all at this point. Now, I'd succeeded in [1], to calculate parameters like H_0 and even the (CMBR-)temperature of the Cosmologic Microwave Background Radiation. It could be engrossed in [19] even more. Indeed, it is hard to believe, that we can actually calculate back until a point of time before the phase jump at Q=1. But the previous contemplations turned out, that both, photons – these behaved like neutrinos in the beginning – and electrons and protons, had had different properties shortly after BB, banish the usual notions of this period to the realm of imagination.

Albeit with a different value for H_0 ($71.9845\,\mathrm{km\,s^{-1}Mpc^{-1}}$), I succeeded in [1], to calculate a CMBR-temperature of 2.79146K with the model. This was close to the 2.72548K, determined with the COBE-satellite. What works in one direction, naturally also works in the other direction. So the 2.72548K of COBE using the values from [1] match an H_0 in the amount of $68.6072\ \mathrm{km\,s^{-1}Mpc^{-1}}$. Indeed, that's less than I calculated. Now, based on the electron, I determined, a new H_0 with an amount of $68.6241\mathrm{km\,s^{-1}Mpc^{-1}}$ in this work. And I was not a little surprised, that it was extremely close to the COBE-value. So I assume, that the new value must be more accurate, than the one calculated in [1]. Thus, it's a matter of verification.

Before starting the calculation of the CMBR-temperature related on the new H_0, I would like to review the basics first.

3.2.1. Basics

The model is based on the fact, that electromagnetic waves don't propagate independently, but as interferences (overlaid) of the metric wave field. The wave length of the metric wave field is equal to the PLANCK-length and proportional Q. In return, the wave length of overlaid waves is proportional $Q^{3/2}$. To the frequencies $\omega_0 \sim Q^{-1}$ and $\omega \sim Q^{-3/2}$applies. That means, both functions intersect somewhere in the past, both frequencies must have had the same value. The intersection point is at Q=½, as we can see well at the lower frequent branch of PLANCK's radiation function. It namely is identical to the frequency response of an oscillating circuit with a Q-factor of Q=½. In the model Q is not only identical to the phase angle $2\omega_0 t$, but it also equals the Q-factor of the models oscillating circuit. Also see [19] for details.

We just determined the frequency ω_0 extremely accurate. Thus, we also know $\omega_{0.5}$ very precise and reversely, we are able to calculate the frequency of the peak value of CMBR and with it, its temperature. Even the bandwidth of the LAPLACE-transform of the first maximum suggests a Q-factor of 0.5. This would correspond to the conditions at the point of time $t_1/4$ with $Q_{0.5}=½$, $\omega_U=\omega_{0.5}$ as well as $r_1/2$, just our coupling-length. The frequency to this point of time amounts to (new value):

$$\omega_{0.5} = \frac{1}{t_1} = \frac{2\kappa_0}{\varepsilon_0} = \frac{\omega_1}{Q_{0.5}} = 2\omega_1 = 3.09408\cdot 10^{104}\,\mathrm{s}^{-1} \qquad (171)$$

That doesn't correspond to the value, which results from the impulse-length of the first maximum, but it is in the magnitude order. Now the conditions at this time are shaped by a very large uncertainty and a part of the emitted frequencies are, because of the large bandwidth, anyway above, others below (171), so that it is well possible that the in-coupling of the cosmologic background-radiation takes place right at this point of time with exactly this centre frequency.

The following contemplations for the in-coupling especially apply to the CMBR. Maybe it seems to be a little bit complicated, but it's just a model, which should reflect reality as well as possible, not the other way around. Now — up to the moment $t_1/4$ of input coupling, the already emitted energy exists as a free wave. The conditions at this point of time are analyzed in detail in section 4.6.5.2. [6] »The aperiodic borderline case«. Now there's going to be the construction of the metric lattice and the signal is coupled in. With the input coupling, a compression of the wavelength occurs i.e. an increase in frequency about the factor $\sqrt{2}$ due to a rotation of the coordinate system about 45°, which we have done in section 4.3.4.3.3. [6] (the metric wave moves in r-direction, the overlaid signals in x-direction).

Furthermore, the metric wave, as well as the energy to be coupled in, exist side by side up to the moment $t_1/4$, both with $\omega_0 \sim \omega_U \sim t^{-1/2} \sim Q_0^{-1}$. But with the in coupling $\omega_U \rightarrow \omega_S$ the temporal dependence changes into $\omega_S \sim t^{-3/4} \sim Q_0^{-3/2}$. This results in a transformation corresponding to a multiplication by a factor ⅔, comparable with the transition from one medium to another with different refraction indices.

But there is yet another, additional effect: In section 4.6.1. [6] we found, that a cube with the edge length r_0 contains four MLE´s altogether. Hence, the energy must be divided among these four MLE´s. With it, the in-coupling frequency decreases additionally with the effect, that ω_s is smaller than $\omega_1/2$ now. The first two effects are depicted in Figure 20. The split we have to take into account elsewhere.

Altogether, to the frequency at the moment of in-coupling the following factor is applied $\omega_s = \frac{1}{4}\cdot\frac{2}{3}\sqrt{2}\,\omega_U = 2\cdot\frac{1}{4}\cdot\frac{2}{3}\sqrt{2}\,\omega_1 = \sqrt{2}/3\,\omega_1 \approx 0.4714\,\omega_1 = 7.29281\cdot 10^{103}\,s^{-1}$. With respect to the energy $\hbar_U\omega_U = 4\hbar_1\omega_1$ only a share of 94.28% incorporated, since $\hbar$ is neither rotated, divided, nor transformed, it is a property of the metric wave field itself. The split has no effect onto the energy balance. The 94.28% relate to a coefficient of absorption of $\varepsilon_v = 0.9428 = \frac{2}{3}\sqrt{2}$. Therefore we are dealing with a *gray body* [21]. The *black body* is only a model, which doesn't exist in nature. The reflected share yields a further decrease of ω_s and with it even of ω_k. So we also have to multiply with ε_v. Interestingly enough the value $\varepsilon_v = 0.9428 = \frac{2}{3}\sqrt{2}$ is close to $\delta = 0.93786$. That should be checked alternatively. However, this is a dead end.

Now to the transfer itself. According to (281 [6]) is the frequency of time-like vectors proportional to $\omega \sim t^{-3/4}$. That equals $\omega \sim Q^{-3/2}$ for the Q-factor. We do the following ansatz:

$$\omega_s = \frac{2\cdot 1}{3\cdot 4}\sqrt{2}\,\varepsilon_v\omega_{0.5}\left(\frac{Q_{0.5}}{Q_{0.5}}\right)^{\frac{3}{2}} = \frac{1}{6}\sqrt{2}\,\varepsilon_v\omega_U\left(\frac{1/2}{1/2}\right)^{\frac{3}{2}} = \frac{1}{6}\sqrt{2}\,\varepsilon_v\omega_U = \frac{1}{3}\sqrt{2}\,\varepsilon_v\omega_1 \tag{172}$$

$$\omega_k = \frac{2\cdot 1}{3\cdot 4}\sqrt{2}\,\varepsilon_v\omega_U\left(\frac{1/2}{Q_0}\right)^{\frac{3}{2}} = \frac{1}{6}\sqrt{2}\,\varepsilon_v\omega_U(2Q_0)^{-\frac{3}{2}} = \frac{1}{3}\sqrt{2}\,\varepsilon_v\omega_1(2Q_0)^{-\frac{3}{2}} \tag{173}$$

$$z = \frac{\lambda_k - \lambda_s}{\lambda_s} = \frac{\omega_s}{\omega_k} - 1 \qquad z+1 = 2\sqrt{2}Q_0^{\frac{3}{2}}$$

$$\frac{\omega_U}{\omega_s} = \frac{3}{\varepsilon_v}\sqrt{2} = 4.5 \qquad z_{ab} = \begin{bmatrix} \dfrac{\omega_1}{\omega_k} & \dfrac{\hbar_1\omega_1}{\hbar\,\omega_k} \\[2ex] \dfrac{\omega_U}{\omega_k} & \dfrac{\hbar_U\omega_U}{\hbar\,\omega_k} \end{bmatrix} = \frac{1}{\varepsilon_v}\begin{bmatrix} 6Q_0^{3/2} & 6Q_0^{5/2} \\ 12Q_0^{3/2} & 12Q_0^{5/2} \end{bmatrix}^{*} \tag{174}$$

*) Correct $m(Q_0^{3/2} - 1)$ resp. $m(Q_0^{3/2} - 1)Q_0$

The factor $2\sqrt{2}$ has nearly the same size as the factor $\tilde{x}$=2.8214’ from WIEN’s displacement law. In section 4.6.4.2.5. we will notice that using $\tilde{x}$ instead of $2\sqrt{2}$, actually intended as an approximation, leads to the only result (136) that is within the error margins of the COBE measurement. Then (174) should read as follows:

$$z = \frac{\lambda_k - \lambda_s}{\lambda_s} = \frac{\omega_s}{\omega_k} - 1 \quad \Big| \quad z+1 = \tilde{x} Q_0^{\frac{3}{2}} \quad \Big| \quad \varepsilon_v = \frac{\tilde{x}}{3} \quad \Big| \quad \frac{\omega_U}{\omega_s} = \frac{9}{\tilde{x}}\sqrt{2} = 4.511145 \qquad (414\ [6])$$

This would correspond to a slightly different refractive index and the factor $\tilde{x}$ in (414 [6]) does not seem implausible either, as it is closely linked to the radiation laws. Apart from that we can see, that it’s better to relate to ω_1 or ω_U. The components z_{1b} are describing the *frequency related*, the z_{2b} however the *energy related redshift*. For ω_k (414 [6]) we obtain a value of $1.00673 \cdot 10^{12} s^{-1}$. Curve 1 in Figure 20b corresponds to the signal ω_s redshifted by $\tilde{x} Q_0^{3/2}$ with the frequency response of a 1st order filter with the Q-factor Q=½. Except for the decline in the upper-frequent range it is identical with ω_k (Curve 6). The conditions before, during and after in-coupling are shown in Figure 20a.

According to (414 [6]), the CMBR redshift has a value of $z = 6.79605 \cdot 10^{91}$, which is orders of magnitude higher than z=1100, as »generally« assumed. On the one hand, this is due to the fact that this model works with variable natural »constants«. Due to the expansion, i.e. the increase of $r_0 \sim Q_0$ (the viewer grows with it) the impression is given, that z is only proportional to $Q_0^{1/2}$. This would correspond to a value of $z = 8.14828 \cdot 10^{30}$ and is still well above 1100. On the other hand, one assumes today that the physical laws shortly after Big Bang did not differ significantly from those of today. So the origin of the CMBR is said to be around 3000 K, the recombination temperature of hydrogen, at a point in time 379000 years after Big Bang. However, the exact results of the calculation of the CMBR temperature in relation to the time $t_1/4$ suggest that we must slowly get used to the idea that it must have been different at that time.

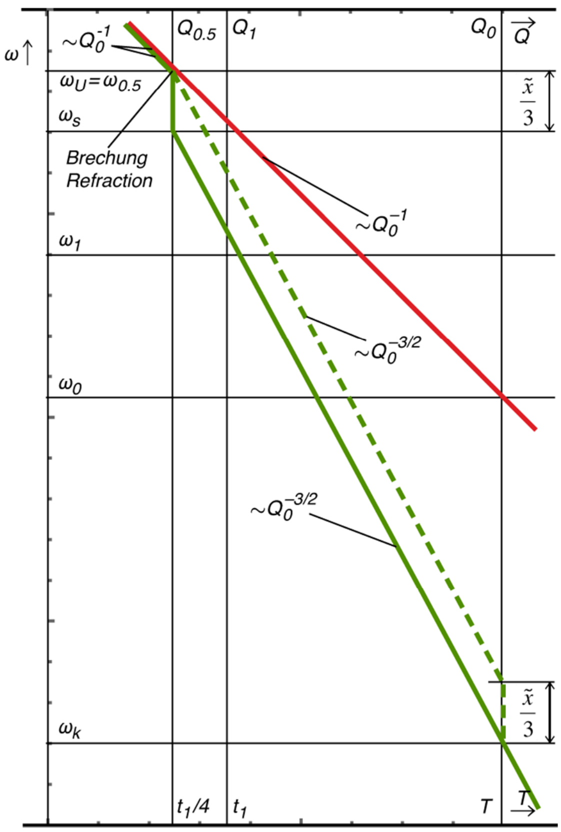

Figure 20a
In-coupling process
and expansion

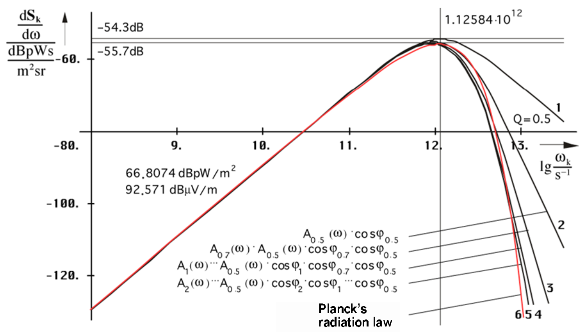

Figure 20b
Intensity of the cosmologic microwave
background radiation with estimate

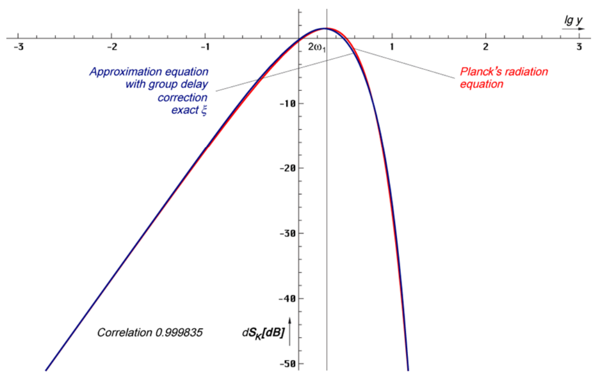

Figure 20c
PLANCK’s radiation-rule and approximation
with group delay correction under application
of the exact function ξ (relative level)

Let us now assume that the decline at the higher frequencies is really caused by the existence of a cut-off frequency. In any case, such a specific course cannot be achieved with a normal LC-low-pass filter of any order. Then the intensity of the cosmological background radiation should have to follow exactly PLANCK's radiation formula. We therefore want to see whether PLANCK's curve 6 in Figure 20b can be approximated from the original curve 1, initially only as an estimate.

We have already realized that a single MLE owns a cut-off frequency (147 [6]), which changes during expansion. During propagation, only the active-part $A(\omega)\cdot\cos\varphi_\gamma$ with $\varphi_\gamma=B(\omega)$ is been transferred (real part). Thus we exactly get the value $\omega_g=2\omega_1$, it applies $\Omega=\omega/(2\omega_1)$. With more exact contemplation we can see, the cut-off frequency may become effective in the first moments of propagation only.

Let's have a look at the moment of in-coupling now: The signal ω_s (curve 1) is multiplied with the frequency response $A(\omega)\cdot\cos\varphi_\gamma$ after in-coupling. As a result, we obtain curve 2, which already comes very close to the PLANCK-curve. Now the signal is transferred to another MLE, at which point the frequency has decreased to a value of $\omega_s/\sqrt{2}$ within this period. We now re-apply the frequency response to the signal obtaining curve 3 (We considered the frequency to be constant at the presentation scaling up the upper cut-off-frequency accordingly instead). Curve 3 comes even closer to the targeted result. We repeat the entire process twice again obtaining graph 4 (ω_s /1) and finally graph 5 (ω_s /2), which figures a very good approximation of PLANCK's graph.

It could be so just thoroughly that PLANCK's radiation-law is really the result of the existence of an upper cut-off frequency of the vacuum. In this connection is to be paid attention to the fact, that that, being applied to time-like vectors emitted directly after Big Bang, must apply to time-like vectors, emitted at a later point of time (e.g. today) too With time-like vectors, it is impossible to determine exactly, when and where they have been emitted, they are timeless. Since no vector can be marked with respect to a second one, each thermal emission must run according to the same legalities (PLANCK's radiation-law) then.

After we have been able to confirm our assumption with the estimate, it is appropriate to carry out an exact calculation. I managed to do this in [19]. The exact course of the result without WIEN shift is shown in Figure 20c.

3.2.2. Calculation

While the temperature of the metric wave field is equal to zero, it's not the case with the CMBR. Since it's about almost black radiation ($\varepsilon_v=0.9428=\tfrac{2}{3}\sqrt{2}$), we are able to calculate the *black temperature* indeed, but we want to work-on with the *grey temperature*. By transposing the WIEN displacement rule with the energetic redshift $z_{22}=12\,\varepsilon_v Q_0^{5/2}$ of (174) we obtain for $\omega_U=2\omega_1$:

$$T_k=\frac{\hbar\omega_k}{\tilde{x}\mathrm{k}}=\frac{\varepsilon_v}{\tilde{x}}\frac{\hbar_1\omega_1}{6\mathrm{k}}Q_0^{-\frac{5}{2}}=0.055693\frac{\hbar_1\omega_1}{\mathrm{k}}Q_0^{-\frac{5}{2}}\qquad \tilde{x}=\begin{cases}2.821439372 & \text{Exactly}\\ 2\sqrt{2} & \text{Approximation}\end{cases}\tag{175}$$

$$T_k=\frac{\hbar\omega_k}{\tilde{x}\mathrm{k}}\approx\frac{1}{3}\frac{\hbar_1\omega_1}{6\mathrm{k}}Q_0^{-\frac{5}{2}}=\frac{\hbar_1\omega_1}{18\mathrm{k}}Q_0^{-\frac{5}{2}}\qquad \varepsilon_v=\frac{\tilde{x}}{3}=0.94048\ \text{Exactly}\tag{176}$$

That's the temperature of the cosmologic background radiation in consideration of the frequency response (see Figure 21Expression (176) can be used as an approximation since the value $\tilde{x}=3+\mathrm{lx}(-3e^{-3})$ is only 0.25% below $2\sqrt{2}$. The item lx corresponds to LAMBERTs W-function (ProductLog[#]). It applies $\mathrm{lx}(xe^x)=x$. You'll find the complete calculation in [19].

With it, we get an extremely simple expression, which corresponds to a value $\varepsilon_v = \tilde{x}/3$. That would be 4× the 3 in one expression and the subspace slightly greyer, as thought. Since we want to know exactly, we will verify even this approach.

$$T_k = 1.002476662335245 \frac{\hbar_1 \omega_1}{18k} Q_0^{-\frac{5}{2}} \qquad \varepsilon_v = \frac{2}{3}\sqrt{2} \qquad (177)$$

$$T_k = 0.997209201884998 \frac{\hbar_1 \omega_1}{18k} Q_0^{-\frac{5}{2}} \qquad \varepsilon_v = \delta \qquad (178)$$

$$T_k = 1.000016126070630 \frac{\hbar_1 \omega_1}{18k} Q_0^{-\frac{5}{2}} \qquad \varepsilon_v = 1.002814779667422 \qquad (179)$$

The last, constructed case gives us the exact value 2.72548K ±0.00057K ($\pm 2.09137 \cdot 10^{-4}$). Table 2 shows all possible solutions once again.

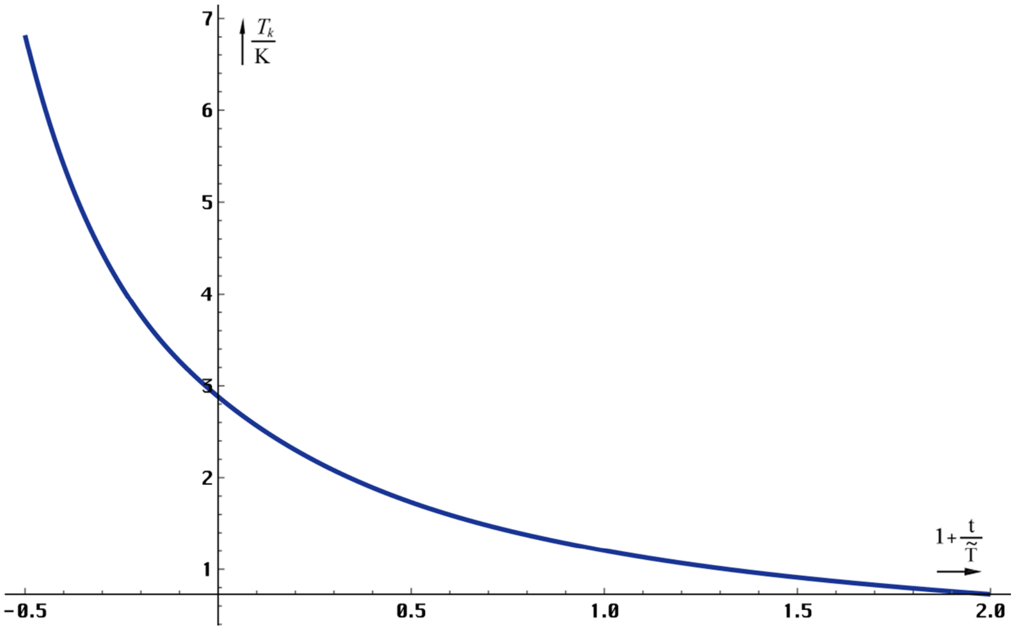

Figure 21
Temporal dependence of the radiation-temperature of the CMBR (linearly)

Value	Q_0	H_0	H_0	CMBR temperature	Absolute difference	Relative deviation
	[1]	[s^{-1}]	[$kms^{-1}Mpc^{-1}$]	[K]	[K]	[%]
(890) [1]	$7.9518 \cdot 10^{60}$	$2.3328 \cdot 10^{-18}$	71.9843	2.791460	+0.06598	+2.42086
(177)	$8.3405 \cdot 10^{60}$	$2.2239 \cdot 10^{-18}$	68.6241	2.732186	+0.00671	+0.24605
$(COBE)_+$	$8.3397 \cdot 10^{60}$	$2.2243 \cdot 10^{-18}$	68.6365	2.726050	+0.00057	+0.02091
$(COBE)_0$	$8.3404 \cdot 10^{60}$	$2.2239 \cdot 10^{-18}$	68.6250	2.725480	±0.00000	±0.00000
(179)	$8.3405 \cdot 10^{60}$	$2.2239 \cdot 10^{-18}$	68.6241	2.725480	±0.00000	±0.00000
(176)	$8.3405 \cdot 10^{60}$	$2.2239 \cdot 10^{-18}$	68.6241	2.725436	-4.4×10^{-5}	-0.00161
$(COBE)_-$	$8.3411 \cdot 10^{60}$	$2.2236 \cdot 10^{-18}$	68.6135	2.724910	-0.00057	-0.02091
(178)	$8.3405 \cdot 10^{60}$	$2.2239 \cdot 10^{-18}$	68.6241	2.717830	-0.00765	-0.28069

Table 2
Calculated and measured CMBR-temperature in comparison with the values of the HUBBLE-parameter

The Q_0- and H_0-values for the COBE-satellite have been determined with the help of (176). The upper and the lower limits of the COBE-values are yellow highlighted. As we can see, the approximation (176) is very good. The value from [1] is much too high and (177) is outside the measuring precision of COBE. Expression (178) is out of question, since its value is below the measured one. Moreover it's not related to the model. That also applies to (179). The approximation (176) in contrast, seems to hit the nail on the had. Whether that's true, further, more precise measurements will prove. Thus, we define:

$$T_k = \frac{\hbar\omega_0}{18\mathrm{k}} Q_0^{-\frac{1}{2}} = \frac{\hbar_1\omega_1}{18\mathrm{k}} Q_0^{-\frac{5}{2}} = 2.725436049\,\mathrm{K} \qquad \Delta = -1.61258\cdot 10^{-5} \tag{180}$$

The calculated value is within the accuracy limits of the value 2.72548K ±0.00057K measured by the COBE-satellite. Thus, the verification can be considered as a success. For the choose of the correct relation to the calculation of T_K I leave the reader room for his own inter-pretations. In addition, we want to calculate the corresponding frequencies for the techni-cians too. With the help of WIEN's displacement rule and (180) we get the following relations:

$$\omega_{max} = \frac{1}{18}\tilde{x}\omega_1 Q_0^{-\frac{3}{2}} = 1.0067316\cdot 10^{12}\mathrm{s}^{-1} \qquad \nu_{max} = \frac{1}{36\pi}\tilde{x}\omega_1 Q_0^{-\frac{3}{2}} = 160.2263\,\mathrm{GHz} \tag{181}$$

The factor σ of the STEFAN-BOLTZMANN radiation rule $\overline{\mathbf{S}}_\mathbf{k} = \sigma T^4 \mathbf{e_s}$ is also a function of Q_0. It is defined as follows:

$$\sigma = \frac{\pi^2 \mathrm{k}^4 T^4}{60\,\mathrm{c}^2\hbar_1^3} Q_0^3 \tag{182}$$

I have to make one more comment at this point. In the context of the publications about the PLANCK-units always is noted a so-called PLANCK-temperature T_0. It's defined in the following manner:

$$T_0 = \frac{\mathrm{m}_0\mathrm{c}^2}{\mathrm{k}} = 1.416784487\cdot 10^{32}\,\mathrm{K} \tag{183}$$

According to this model it should actually equal the temperature of the metric wave field, to be correct even divided by 8π. But that's not the case. According to [24] this results from the GIBBS fundamental equation to:

$$T_0\,\mathrm{dS}_0 = \mathrm{d}(\mathrm{mc}^2) - \omega\mathrm{dL} \tag{184}$$

$$T_0\,\mathrm{dS}_0 = \mathrm{d}(\mathrm{m}_0\mathrm{c}^2) - \hbar\omega_0\mathrm{dL} = 0 \qquad T_0 \equiv 0\mathrm{K} \tag{185}$$

because of $\omega_0 \neq$ const. That well fits the observations. Thus, the famous expression $\mathrm{mc}^2 = \hbar\omega$ is nothing other than a special case of the GIBBS fundamental equation for $T_0 = 0$ at the level of the metric wave field. It thermally speaking, does not appear – otherwise we would have been vaporised long ago. For the case L=0 the temperature would be expression (183) divided by 8π. Thus, the correct PLANCK-temperature T_0 is equal to zero. But it's possible to specify an initial CMBR-temperature for $Q_0=1$. It amounts to $T_{K1} = T_K\, Q_0^{5/2} = 5.4753571754114\cdot 10^{152}$K.

3.3. The gravitational constant

3.3.1. Close range

After setting-up the Concerted System of Units maybe one or the other has noticed, that we forgot one fundamental „constant“, namely NEWTON‘s gravitational constant G. That’s because one can do very well even without it. But since it’s used very often, we will deal with it more detailed in the next section.

We have seen, that PLANCK's quantity of action is not a constant but a function of space and time. From the definition of κ_0 (114) arises, that this must be applied even to NEWTON's gravitational constant. We get after rearrangement:

$$G = \frac{c^3}{\mu_0\kappa_0\hbar H} = \frac{2c^3 t}{\mu_0\kappa_0\hbar} = c^2\frac{R}{M_1} = c^2\frac{r_0}{m_0} \tag{186}$$

The gravitational constant is obviously a function of the local conditions. By insertion of (23) we finally get:

$$G = \frac{c^2}{\mu_0\kappa_0\hbar_1} Q_0 R \tag{187}$$

At this point, the product Q_0R appears for the first time, which leads, because of the logarithmic periodicity of the universe, to the interesting question, what is there anyway in the distance Q_0R? Possibly there is a superordinated universe of which our own only forms a microscopic part (r_0)? The cosmologic background-radiation, be continued accordingly, would form the metric radiation-field of that superordinated universe then.

On the other hand there is the mass M_1 in the denominator of (186) and the mass M_2 (fixed value) in (187). The term R=2cT indicates G acting along the constant wave count vector. In section 3.1.4.1. in Figure 14 we can see, that M_1 depends on time and distance, m_0 has the value M_1 at intervals of R, whereas with M_2 it’s about a historic value, only possible, if we go back in time. Thus, we can assign R to time, Q_0 however to space-time.

3.3.1.1. Temporal dependence

We replace Q_0 and R with the corresponding temporal functions, then we transform it onto our local coordinates or vice-versa:

$$G = \frac{c^2}{M_2}\tilde{R}\left(1+\frac{t}{\tilde{T}_0}\right)\tilde{Q}_0\left(1+\frac{t}{\tilde{T}_0}\right)^{\frac{1}{2}} \qquad G = \tilde{R}\tilde{Q}_0\frac{c^2}{M_2}\left(\frac{2\kappa_0 t}{\varepsilon_0}\right)^{\frac{3}{2}} \sim t^{3/2} \tag{188}$$

$$G = \tilde{R}\tilde{Q}_0\frac{c^2}{M_2}\left(1+\frac{t}{\tilde{T}_0}\right)^{\frac{3}{2}} \sim Q_0^3 \sim \beta^{-2} \qquad G = \tilde{R}\tilde{Q}_0\frac{c^2}{M_2}\left(\frac{t}{t_1}\right)^{\frac{3}{2}} = \tilde{G}Q_0^3 \tag{189}$$

The term before the bracket equals the local $\tilde{G}$ (frame of reference) of the gravitational constant G. The right-hand expressions apply to t, reckoned from BB on.

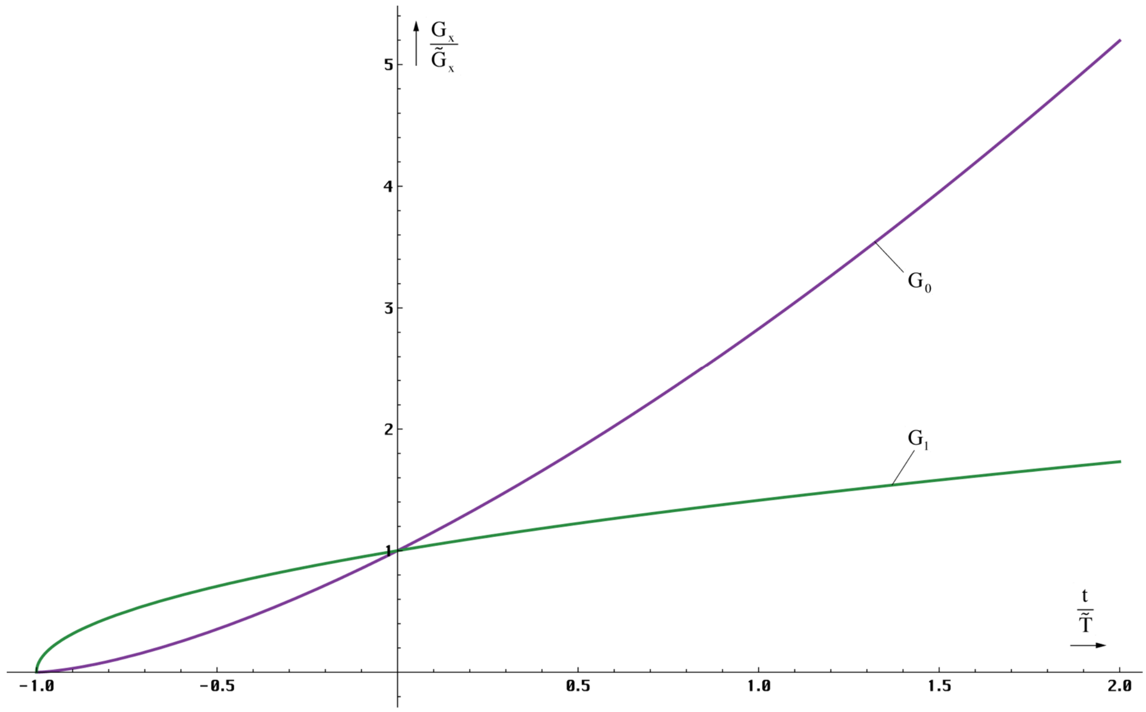

Figure 22
Temporal course of the gravitational constant at the point r=0 (linear scale)

The temporal course at the point r=0 is shown in Figure 22 and 23. In the early beginning of expansion the value of the gravitational constant was equal to zero, as we can see in Figure 22 very well. The calculation turns out the same result. The (new) value of the gravitational constant 1s after BB is recorded in Figure 23 (new value). For the value G_2 at point of time t_1 applies:

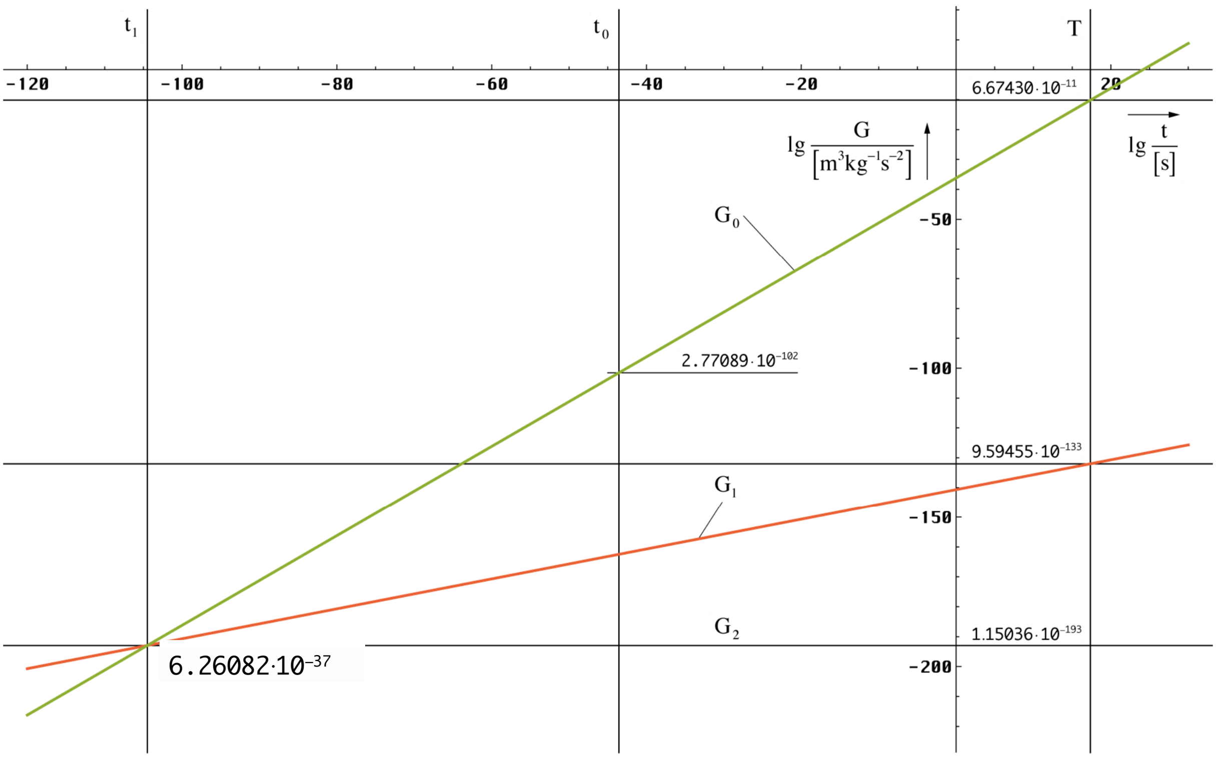

Figure 23
Temporal course of the gravitational constant with respect to the local age (logarithmic scale)

$$G_2 \;=\; c^2 \cdot 1 \cdot \frac{r_1}{M_2}\left(\frac{t_1}{t_1}\right)^{\frac{3}{2}} \;=\; GQ_0^3 \;=\; 1.15036 \cdot 10^{-193}\,m^3 kg^{-1} s^{-2} \qquad (190)$$

Therefrom results, that gravity could not have played an essential role to a point of time $t<7.7\,ns$ (quantum-universe). Therefore gravity and quantum-effects are excluding each other. But this exclusion is not absolute. Rather there is a transition-zone, in which as well gravity as quantum-effects in the scale of the entire universe have been existed. To the point of time $t=0$ and, qualitatively seen, shortly thereafter there was no gravity anyway.

The expansion of the universe, increases also the distance of two masses, which are coupled by gravitational forces. That increase is compensated by the increase of the value of the gravitational constant. Whether this compensation is complete, we will examine more exactly at the end of this section.

3.3.1.2. Spatial dependence

If a temporal dependence exists, so there is also a spatial dependence. We directly get the relation by expansion of (187) with the navigational gradient (64), the world radius depends on time only.

$$G \;=\; \frac{2c^3 t}{\mu_0 \kappa_0 \hbar}\,(2\omega_0 t - \beta_0 r) \qquad (191)$$

$$G \;=\; \tilde{R}\tilde{Q}_0 \frac{c^2}{\mu_0 \kappa_0 \hbar_1}\underbrace{\left(1+\frac{t}{\tilde{T}}\right)}_{\text{Temporal}}\underbrace{\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)}_{\text{Spatial}} \qquad (192)$$

The course for $t=0$ is shown in Figure 24. It shows an interesting phenomenon. The value of the gravitational constant decreases down to zero when approaching the local world-radius R/2. Beyond this point however, it becomes negative, the attraction turns into a repulsion.

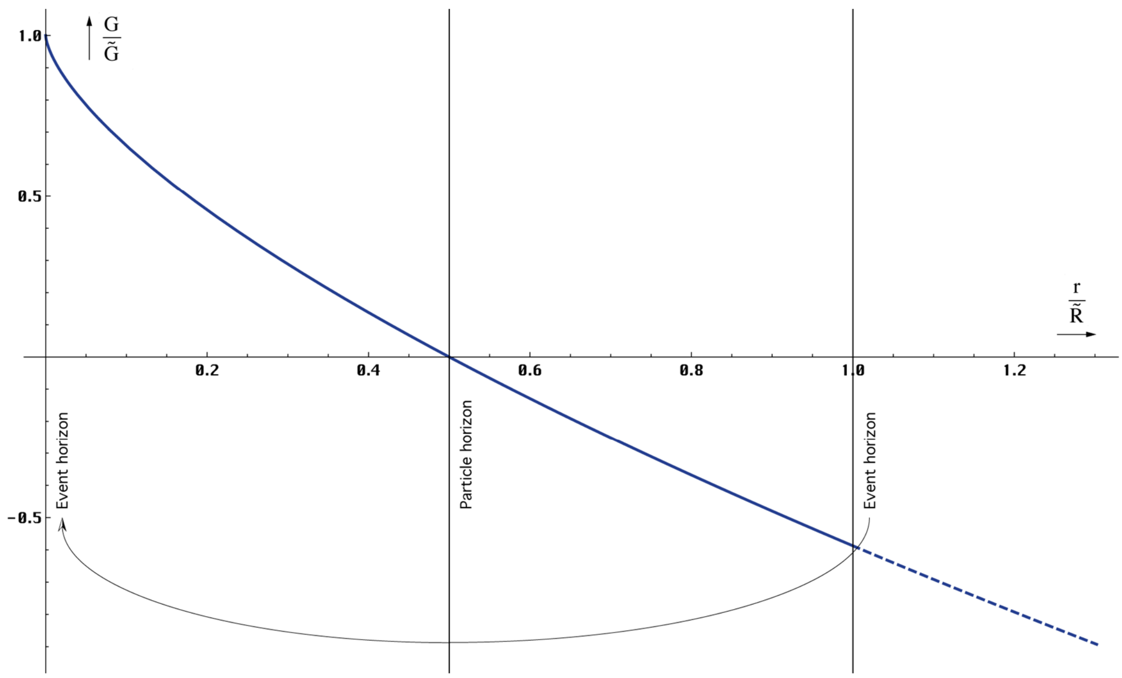

Figure 24
Spatial dependence of the gravitational constant to the point of time T (linear scale)

That‘s due to the fact, that gravity acts along the constant wave count vector with the maximum length 2cT and it doesn’t leave the universe, far from it, it reapproaches the observer with distances >cT. Now the attractive force is opposite to the moving direction, leading to the negative sign of G. Both, the observer and even the starting point of the constant wave count vector are *located* at the event horizon, that is to say. It’s an effect of the 4D-topology. The course behind the second event horizon is increasing, because it‘s *situated* in the future.

The calculation of G_1 at intervals of $r=R/2$ for $t=0$ is somewhat more complicated. With $r=R/2$ namely, it is equal to zero. The value, we are actually looking for is a few steps from there at intervals of $r=R/2-r_1$ and (192) is not suited for such a small distance to the edge. We need to embed the exact expression (56):

$$G = \tilde{R}\tilde{Q}_0 \frac{c^2}{\mu_0 \kappa_0 \hbar_1} \underbrace{\left(1+\frac{t}{\tilde{T}}\right)}_{\text{Temporal}} \underbrace{\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}} - \frac{1}{\tilde{Q}_0}\right)^{\frac{2}{3}}\right)}_{\text{Spatial}} \qquad (193)$$

The value G_1 occurs with $Q_0=1$. It applies:

$$G_1 = \frac{r_1 c^2}{M_1}(1-(1-1/1)^{2/3}) = \frac{r_1 c^2}{M_1} = GQ_0^{-2} = 9.594550966819 \cdot 10^{-133} m^3 kg^{-1} s^{-2} \qquad (194)$$

Thus, G decreases towards the edge $R/2-r_1$ to the value G_1. There is no frame of reference possible behind, G_2 is not reached. Since the attractive force F_G decreases geometrically with r^2 and G with $r^{2/3}$, it adds up to $F_G \sim r^{-8/3}$. In addition, there is the ever increasing delay. That means, that the gravitational constant no longer plays a role with greater distance. A greater distance means distances of $r>0.01R$. From this point on, other effects come into play.

Because of the definition (186) G is a local parameter in fact. If we calculate the value in a certain distance, it doesn’t mean, that G has the same size everywhere on the way there. The attractive force F_G between two bodies, moved with the metrics, is defined alongside a constant wave count vector. For a correct equation of motion we have to build the integral across the whole reach with $dr=r_0$.

Since r_0 is not evanescent (infinite structure), but has a particular minimum size (finite structure), the rules of infinitesimal calculus are actually applicable only then and only approximately, if r_0 is small with respect to the world radius R. That’s the case for the predominant part of the universe. More on this in the next section.

3.3.2. Far range

In section 2.3.4. we found with (64) an expression for the temporal and spatial dependence of PLANCK's elementary-length r_0, figuring at least locally a scale for the proportions (distance). On this occasion I refer once again to the fact that this is *also* applied to the size of material bodies, which is changing in the same measure as r_0. Otherwise we could not observe any expansion either.

Just particularly it is a matter of the mutual distances of material bodies. These follow a function, which differ with the considered distance, since quantity and expansion-velocity of the PLANCK elementary-length is changing with ascending distance to the coordinate-origin. But only distances with the starting-point in the origin should be considered here. Of considerable importance for deeper contemplations is even the number of line elements (MLEs) along an imagined line with the length r (wave count vector $\mathbf{\Lambda}$).

We distinguish two cases in this connection: Wave count vector with constant r and r with constant wave count vector. Latter one fits the existing circumstances to the best, since we can assume that no point is distinguished to other points in the cosmos. The average relative velocity with respect to the metrics at the coordinate-origin is equal to zero at free fall. This should be so everywhere then. With it, the expansion of the universe can be traced back to the expansion of the metrics alone. This corresponds to the case of a constant wave count vector.

3.3.2.1. Constant distance

Because of the *real lattice constant* r_0 the wave count vector $\mathbf{\Lambda}$ for smaller distances r is defined in the following manner:

$$\mathbf{\Lambda} = \frac{r}{r_0}\mathbf{e}_r \tag{195}$$

$\mathbf{e_r}$ is the unit-vector. In the following, we consider only the Figure Λ however. For larger distances, we have to replace Λ by $d\Lambda$ and r by dr using the corresponding expression (64) for r_0:

$$d\Lambda = \frac{1}{\tilde{r}_0}\frac{dr}{(1+t')^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} \qquad \text{with } t' = \frac{t}{\tilde{T}} \tag{196}$$

To the solution we replace as follows (it applies $\tilde{R}/\tilde{r}_0 = \tilde{Q}_0$):

$$d\Lambda = \frac{3}{2}\frac{\tilde{R}}{\tilde{r}_0}\frac{r'^2}{a^2 - r'^2}dr' \qquad \text{with } r' = \left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}} \;\Big|\; a^2 = (1+t')^{\frac{1}{2}} \;\Big|\; dr = \frac{3}{2}\tilde{R}r'^2dr' \tag{197}$$

$$\Lambda = \frac{3}{2}\tilde{Q}_0\int\frac{r'^2}{a^2 - r'^2}dr' = \frac{3}{2}\tilde{Q}_0\left(a\,\mathrm{artanh}^{*)}\frac{r'}{a} - r'\right) \tag{198}$$

*) arcoth for |r| > ct (behind the particle horizon)

$$\Lambda = \frac{3}{2}\tilde{Q}_0\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{4}}\mathrm{artanh}\frac{\left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}}}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{4}}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}}\right) \qquad \text{def } \Lambda_0 = \frac{R}{2r_0} = \frac{Q_0}{2} \tag{199}$$

The wave count Λ follows the blue function depicted in Figure 25. Approaching to half the world radius (R/2), it seems to be, that Λ strives towards infinity. If we want to define a finite wave count Λ_0, we take only a certain part of the world radius to calculate the wave count for it. Because of $R/(2r_0) = Q_0/2$ we opt for that value.

The value amounts to 0.273965R, that is 54.79% of the distance to the particle horizon (cT). In total however an infinite value will not be reached, since r_0 becomes smaller and smaller going to r_1. Out there, at Q=1 is the back of beyond, we reached the particle horizon.

At first I guessed the value to be $\Lambda_1 = Q_0^2$, since even $R = r_1 Q_0^2$ applies. But that's not the case. The little more ambitious calculation for $r = R/2 - r_1 \rightarrow 1 - 10^{-120}$ under application of the power series for $(1-x)^{⅓}$, multiple substitutions up to the transformation of the function artanh→ arsinh→ ln, turns out $\Lambda_1 = \frac{3}{2} Q_0 \ln Q_0 \approx 210\, Q_0 = 1.7549547113\cdot 10^{63}$ using the value of (108). For Λ_1 applies $t' \equiv t \equiv 0$ i.e. a constant wave count vector. But by expansion and wave propagation „outwards“ the phase angle $2\omega_0 T = Q_0 \sim t^{½}$ increases continuously. And because of (4) $\Lambda_1(T) = \frac{3}{2}\sqrt{bT}\ln\sqrt{bT}$ applies with $b = 2\kappa_0/\varepsilon_0$.

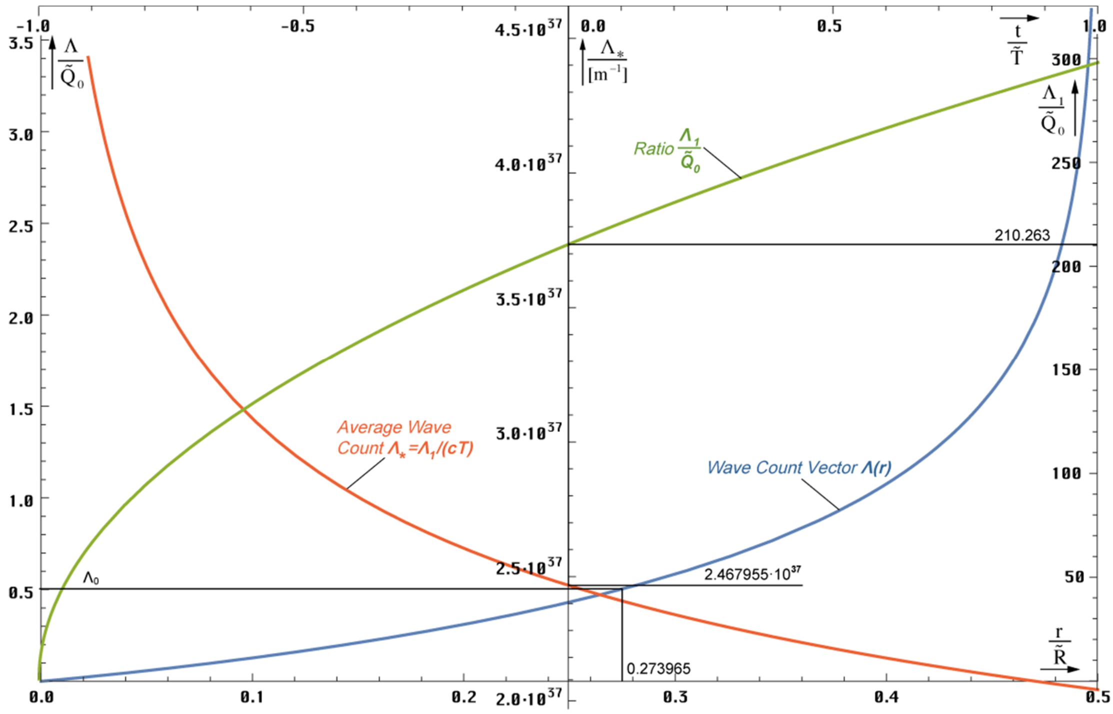

Figure 25
Wave count vector as function
of distance r and t

The temporal dependence for several initial distances r is shown in Figure 26. The larger the considered length, the later on the point of time, the wave count vector is defined from. That's easy to understand, we can regard a length as existent only then, when the world-radius is larger or equal to. If the world-radius is smaller, so such a length doesn't exist. Therefore, lengths larger than 0.5R aren't defined at present and function (199) does not have a real solution before a value of e.g. t=0.75T is reached (t=0 is the present point of time). Altogether, the wave count decreases. That results from the fact that we are considering a constant length with expanding r_0. So it happens, that MLEs are permanently „scrolled out" at the „tail" leading to a degradation of the wave count vector at the same time.

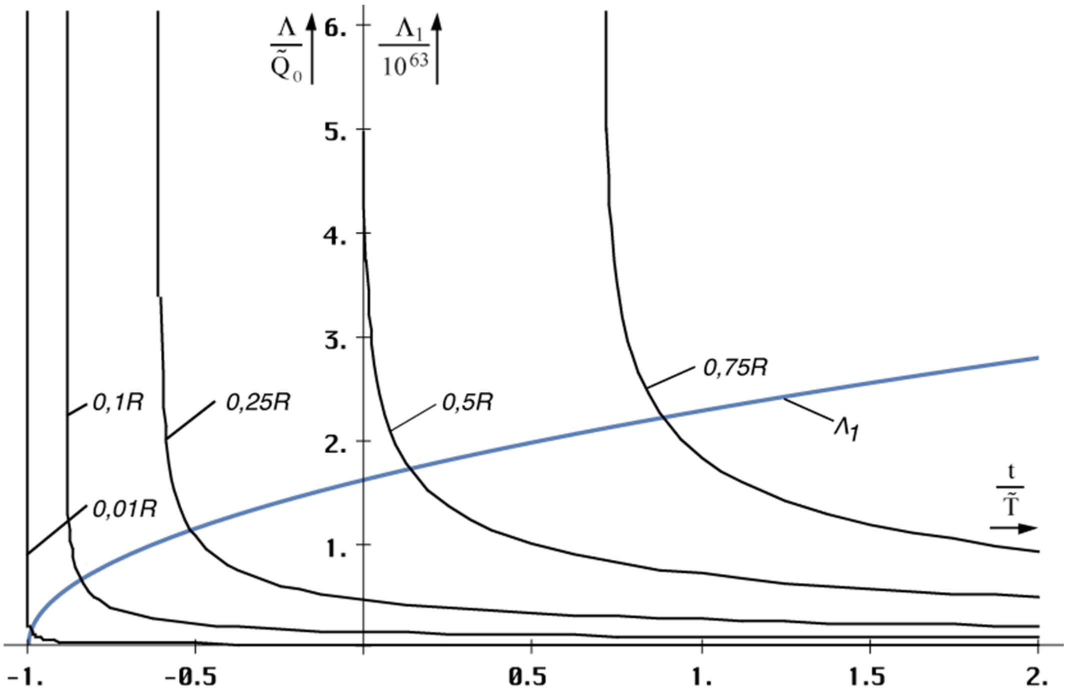

Figure 26
Temporal dependence of the wave count vector
for several distances r

3.3.2.2. Constant wave count vector

3.3.2.2.1. Solution

At first we start with the left expression of (199) for t=0 (a=1). It specifies the quantity of the wave count vector at the present point and at each point of time, if we want to assume it as constant. We just look for the function F(a, $\tilde{r}'$) being nothing other as the temporal dependence on a given length $\tilde{r}'$. See (196) for a(t).

$$\Lambda = \frac{3}{2}\tilde{Q}_0\left(\operatorname{artanh}\tilde{r}' - \tilde{r}'\right) = \frac{3}{2}\tilde{Q}_0\left(a\operatorname{artanh}\frac{\tilde{r}'F}{a} - \tilde{r}'F\right) = \text{const} \qquad (200)$$

An explicit reduction by differentiating and zero-setting (the left expression turns to zero on this occasion) leads to the trivial solution F=0. Otherwise, only an implicit solution can be found as solution of the equation:

$$a\operatorname{artanh}\frac{\tilde{r}'F}{a} - \operatorname{artanh}\tilde{r}' - \tilde{r}'(F-1) = 0 \qquad r(t) = \tilde{r}F^3(t) \qquad (201)$$

or in »Mathematica«-notation F1[t,r]:

```
Fa1=Function[a=FindRoot[#1*ArcTanh[#2/#1*x]-ArcTanh[#2]-
#2*(x-1)==0,{x,1}, MaxIterations->30]; (Round[(x/.a)*10^7]/10^7)^3];     (202)
F1=Function[Fa1[(1+#1)^.25,(2*#2)^(1/3)]];
```

In this connection we have to be particular about the method (tangent-method) and the initial value. There was a problem using secant method. The temporal course is shown in Figure 27. There is only a limited definition-range for the solution. It is temporally bounded below by the spatial singularity, the considered length is greater than the world-radius and doesn't exist yet. The greater the considered length, the smaller the definition range. With world-radius the space-like vector R/2=cT is meant.

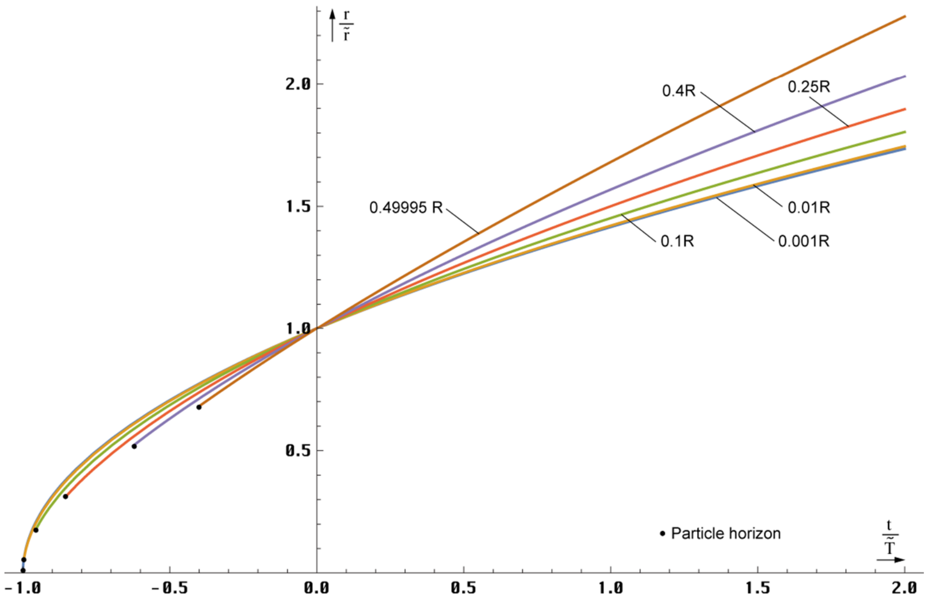

Figure 27
Temporal dependence
of a given distance r

3.3.2.2.2. Approximative solutions

A simple solution for small r explicitly arises from (201) under application of the two first terms of the TAYLOR series for the function artanh:

$$r = \tilde{r}\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} \approx \tilde{r}\left(1+\frac{1}{2}\frac{t}{\tilde{T}}\right) \qquad \text{for } \tilde{r} \quad 0.01\,\tilde{R} \tag{203}$$

This exactly corresponds to the behaviour of PLANCK's elementary-length (MLE) and is valid until 0.01R approximately. For larger distances, the ascend is larger. First we examine the course in the proximity of t=0 as well as the ascend Δr/Δt with $\Delta t=2\cdot 10^{-3}$. With root-functions the ascend (dr/dt) is equal to the exponent m in this point:

$$r = \tilde{r}\left(1+\frac{t}{\tilde{T}}\right)^{m} \approx \tilde{r}\left(1+m\frac{t}{\tilde{T}}\right) \tag{204}$$

This is shown in Figure 28. It is in the range of 1/2…3/4. Using the function Fit[] with the help of (79) approximations of different precision for the exponent m can be found:

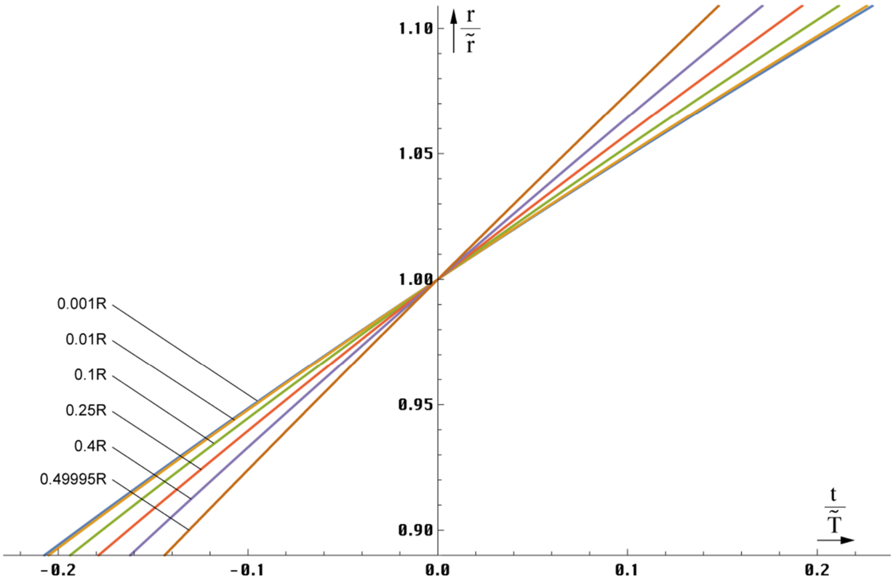

Figure 28
Ascend of several given distances in the proximity of t=0

```
mmm = {{0, .5}};
For[x = 0; i = 0, x < .499, (++i), x += 0.01;
AppendTo[mmm, {x, N[F1[0.0001, x] - F1[0, x]]/0.0001}]]
Fit[mmm, {1, m, m^2, m^3, ...}, m]
```
(205)

$$m \approx 0.513536 + 0.17937r + 0.490927r^2 \qquad \text{with } r = \mathrm{r}/\tilde{R}$$

$$m \approx 0.500(822) + 0.50052r - 1.13082r^2 + 2.16233r^3 \tag{206}$$

$$m \approx 0.500(843) + 0.598206r - 3.45991r^2 + 18.3227r^3 - 42.6995r^4 + 38.0733r^5$$

The third equation of (206) has an accuracy of $\pm 4.83\cdot 10^{-3}$ and is suitable even for calculations with more extreme demands. At close range it is better to leave out the parentheses. Indeed, there is a need to consider the restricted definition-range, which is not being co emulated automatically by the approximative solution. It is pointed out here once again that the distances and velocities, regarded in this section, are a matter of space-like vectors having nothing to do with the time-like vectors considered in section 4.3.4.4.6. of [6] Cosmologic red-shift.

3.3.2.3. The HUBBLE-parameter

Having defined the HUBBLE-parameter only for small lengths and PLANCK's elementary-length (r_0) so far, following the relationships for a radiation-cosmos (m=1/2), we have now to correct our statements for larger distances. With m=m(r) the HUBBLE-parameter $H=\dot{r}/r$ becomes a function of distance too:

$$H = \frac{m}{\tilde{T}+t} \qquad H_0 = \frac{m}{\tilde{T}} \tag{207}$$

The course is shown in Figure 29. The metrics examined by this model is a non-linear metrics. With it, the question has become unnecessary, whether our universe is a radiation- or dust-cosmos. The answer is – as well, as. It's a question of the dimensions of the considered area. For small lengths, the distance behaves like a radiation-cosmos, in the range between zero and 0.5R like a dust-cosmos, with 0.5R like photons overlaid the metrics.

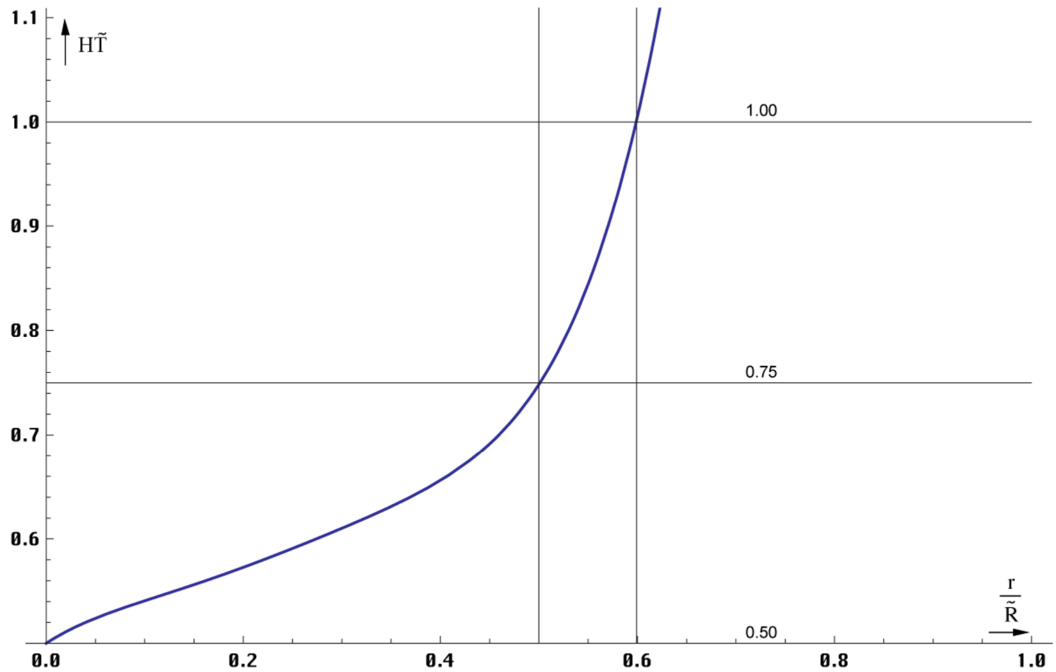

Figure 29
HUBBLE-parameter as a function of the distance for t=0, the values r>0.5R are extrapolated

We get the expansion velocity v by the differentiation of equation (204) with respect to the time t. In the close range m=½ applies, leading to the well-known expression $H_0=1/(2T)$. The approximation applies to $t \ll T$. That's actually always the fact, because we do not grow so old anyway.

$$v = \frac{d}{dt}\tilde{r}\left(1+\frac{t}{\tilde{T}}\right)^{m} = m\frac{\tilde{r}}{\tilde{T}}\left(1+\frac{t}{\tilde{T}}\right)^{m-1} = \tilde{H}\tilde{r}\left(1+\frac{t}{\tilde{T}}\right)^{m-1} \approx \tilde{H}\tilde{r} \tag{208}$$

The expansion-velocity $H_0 r$ as a function of the distance is shown in Figure 30. The speed of light is reached in an essentially minor distance as with the standard-models, but only on paper. While the size of r_0 at 0.5R=cT tends to r_1, the expansion speed along the time-like world line at this point is not infinite, rather it's smaller than c (0.75c).

Otherwise we found out, that the maximum propagation speed $|\underline{c}_{max}|$ of the metric wave field only amounts to 0.85166135 c. But furthermore the world-radius should be cT, whereas time-like vectors with up to 2cT should be possible. So we have to do with four different distances resp. velocities, which all don't seem to fit together. But using this model it's possible to solve this conflict. Let's have a look on Figure 31, which except for r_K, is a true-to-scale representation.

We assume the front of the metric wave field to propagate with the maximum velocity $\underline{c}_{max}$=0.85166135c (Propagation share). The share r_M of the world radius, caused by it, would

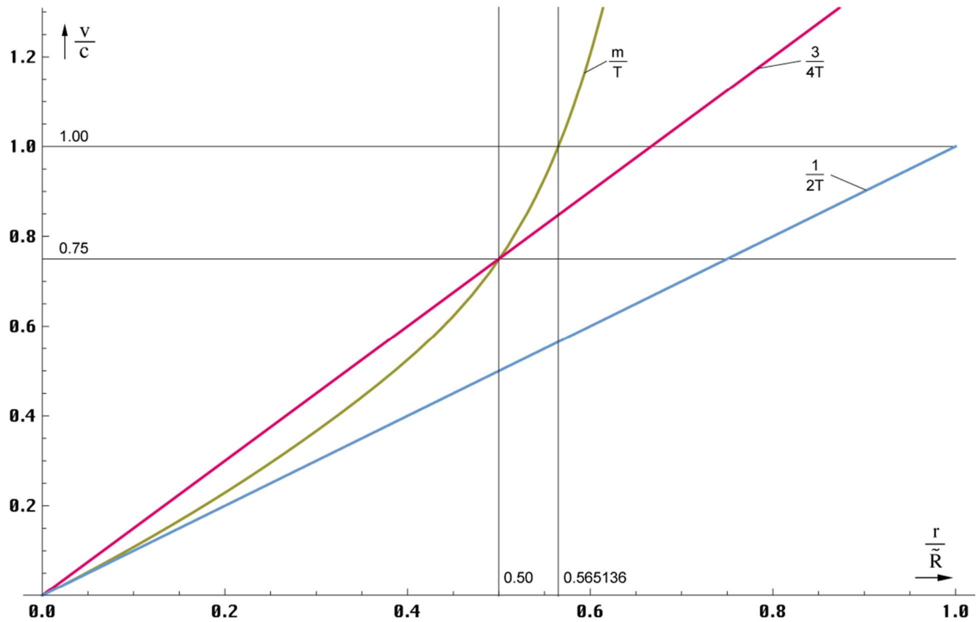

Figure 30
Expansion-velocity as a function of the distance for t=0, the values r>0.5R are extrapolated

be 0.85166135cT then. However, there are different values stated in the figure, why, we will see later. As noticed furthermore, the constant wave count vector r_K up to the vicinity of R/2 is running on the same track as the incoming time-like vector r_T with 0.75 c (arc length 0.75 cT). But it's tilted about the angle α_1, so that we have to sum geometrically. In addition the partial vector ④ is curved. But the object we are looking for is the space-like vector r_R (expansion share ②). As next we flatten the partial vector ④ by bending it up to ⑤. Then we project it onto r_R, it applies $r_R=-r_K\cos\varphi$ with the angle $\varphi=\arg\underline{c}=\alpha-\pi/2=48.6231°$ of the metric wave function. With a phase angle of Q=0.8652911138 we obtain with the angle $\alpha=2.419430697 \triangleq 138.6231678°$ the following solution:

$$c = \sqrt{c_M^2+c_R^2} = \sqrt{c_M^2+c_K^2\cos^2\alpha} = c\sqrt{0.85166^2+0.75^2\cos^2 2.41943} \tag{209}$$

$$c = c\sqrt{0.85166^2+0.562784^2} = 1.02081c \qquad \Delta=+2.08\cdot10^{-2} \tag{210}$$

This result isn't notably exact and even worse than that in [7], which is barely correct btw. since there values for β, φ and c_M have been used, misfitting Q=1 (case 13). We will see, if we are able to get a more exact result. If we get granular on Figure 31, we see, that r_K is curved and, even in this state, protrudes significantly beyond r_R. Thus, if we want to get a correct relation, we have to impose it with a correction factor.

On the one hand, there is the relation $RS=r_K/r_N$, we can calculate. On the other hand, with the classic electron radius in section 3.1.5., there was a similar case with which we had defined the correction factor ζ=1.01619033 eq. (141). What works in the microscopic scale, may even work in a macroscopic scale. Let's try to plug ζ into (209). But if we want to obtain a correct result, we have to correct Q and the associated angles as well as the vectors r_M and r_R too. That means, the particle horizon does not move with $\underline{c}_{max}$, but a little bit slower. The maximum is situated behind the particle horizon anyway.

That would be the third case, in which an object is not at the optimal, that means at the „location" we calculated, but slightly above or below. One possible reason could be, that infinitesimal calculus, as already suggested, reaches its limits in this point. Because $dr=r_1$ is no longer small with respect to r_0. So certain states could be excluded, the values „latch". For the case, that ζ is the significant correction factor, the following parameters come into play:

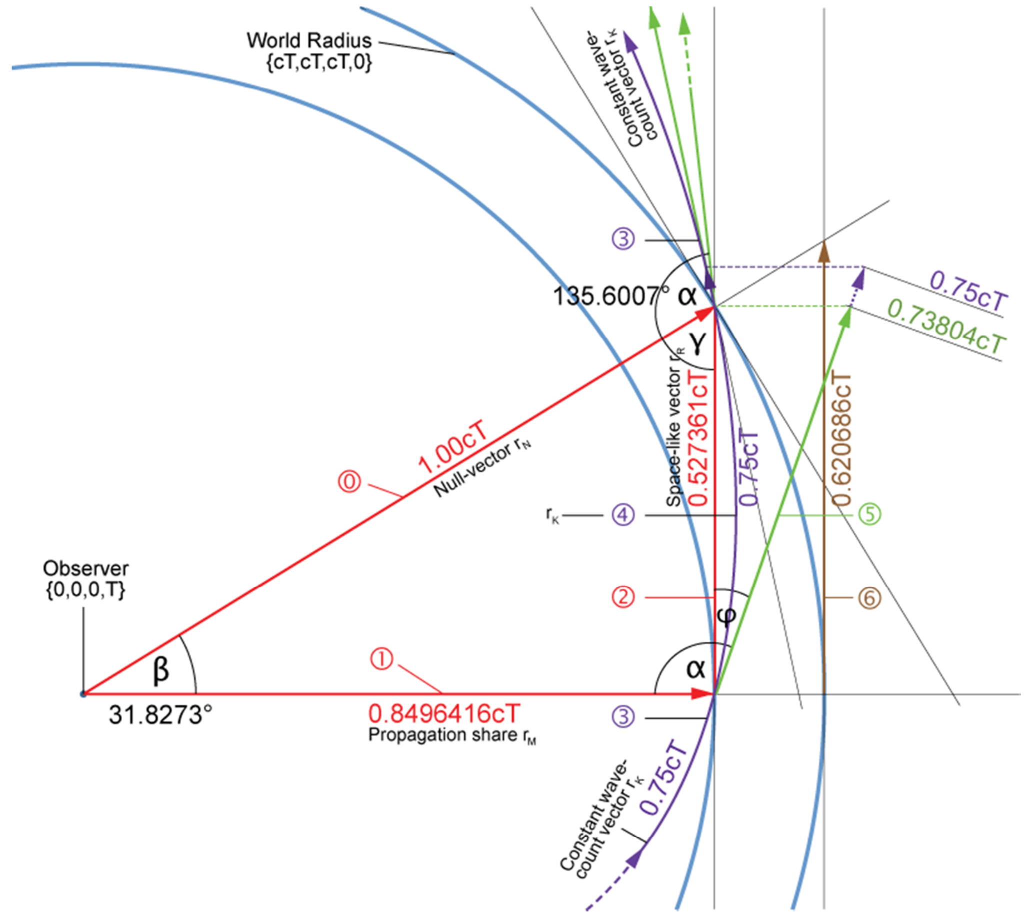

Figure 31
Expansion velocity and world radius version 6

Q=0.93281140128, α=2.3666789294≙135.600714°, φ=45.600714°, β= 31.82728°, c_M=0.8496416 and c_R=0.527361 (values from Figure 31). Q is quite central between Q_{max} and Q=1 in this case.

$$c = \sqrt{c_M^2 + \zeta^{-2} c_K^2 \cos^2\alpha} = c\sqrt{0.849642^2 + 0.535861^2 \zeta^{-2}} = 1.00c \qquad \Delta = +2.22 \cdot 10^{-16} \quad (211)$$

That equals MachinePrecision. It's no wonder, however, as we determined the associated values especially for that purpose, namely in the following way:

```
Q = SetPrecision[q /. FindRoot[Sqrt[(RhoQ[q])^2 +
        (0.75/zeta*Cos[AlphaQ[q]])^2] -1 == 0, {q, .9, 1}], 20]
alpha = AlphaQ[Q]
phi = alpha -π/2                                              (212)
beta= ArcTan[Sqrt[1-cM^2]/cM]
cM = RhoQ[Q]
cR = -0.75/zeta*Cos[alpha]
RS = RS[Q]
```

You will find the not yet defined functions in the annex. Now we come to the ratio RS=r_K/r_N. Of course, it may be used as correction factor too. Indeed, we can make use of the following relation:

$$RS^2 \approx \zeta^3 \qquad \text{resp.} \qquad \frac{RS^{2/3} - \zeta}{\zeta} = -4.71403 \cdot 10^{-5} \quad (213)$$

values according to (211). Applying $RS^{2/3}$ instead of ζ in (211), we get a residual error of $1.311 \cdot 10^{-5}$. Nevertheless it's not about the same value. If we try to equate both sides of (213), we are unable to define an exact solution. Then, the best result has a residual error of $-6.344 \cdot 10^{-4}$ for both values. We can also generate an exact solution using RS.

Since I wonder about it exactly, I calculated a great many of alternatives having entered the values in table 3. The conclusion is, the universe expands somewhere on the level between Q_{max} and Q=1. It is reminiscent of a surfer, who does not run on the crest of waves, but always a little off.

Nr	Name	Q	c_M/c	$-\frac{3}{4}\cos\alpha$	F	c_R/c	α°	β°	φ°	c	Δ
1	Maxζ	0.8652911	0.851661	0.562784	ζ	0.553856	138.623	31.607	48.623	1.015920	$+1.5915\cdot10^{-2}$
2	MaxR	0.8652911	0.851661	0.562784	R	0.554615	138.623	31.607	48.623	1.016330	$+1.6329\cdot10^{-2}$
3	Max1	0.8652911	0.851661	0.562784	1	0.562784	138.623	31.607	48.623	1.020809	$+2.0809\cdot10^{-2}$
4	0Rζ	0.9242251	0.850105	0.535861	ζ	0.526448	135.970	31.777	44.030	0.999913	$-8.6977\cdot10^{-5}$
5	0RR	0.9242251	0.850105	0.535861	R	0.526613	135.970	31.777	44.030	1.000000	$-1.1102\cdot10^{-16}$
6	0ζζ	0.9328114	0.849642	0.535861	ζ	0.535861	135.601	31.827	45.601	1.000000	$+2.2204\cdot10^{-16}$
7	0ζR	0.9328114	0.849642	0.535861	R	0.527361	135.601	31.827	45.601	1.000013	$+1.3111\cdot10^{-5}$
8	R~ζ	0.9353288	0.849495	0.534878	≡	0.526393	135.493	31.843	45.493	0.999365	$-6.3441\cdot10^{-4}$
9	Qre1	0.9470231	0.848757	0.530330	1	0.530330	135.000	31.923	45.000	1.000818	$+8.1870\cdot10^{-4}$
10	QReζ	0.9470231	0.848757	0.530330	ζ	0.521917	135.000	31.923	45.000	0.996386	$-3.6137\cdot10^{-3}$
11	QReR	0.9470231	0.848757	0.530330	R	0.521804	135.000	31.923	45.000	0.996327	$-3.6729\cdot10^{-3}$
12	000	0.9501382	0.848544	0.529125	1	0.529125	134.869	31.946	44.870	1.000000	±0.0000000
13	[7]	1.0000000	0.851661	0.520409	1	0.524093	132.864	31.607	42.465	0.992791	$-7.2090\cdot10^{-3}$
14	Q1R	1.0000000	0.844304	0.510203	R	0.519025	132.864	32.402	42.864	0.910785	$-8.9214\cdot10^{-3}$
15	Q1ζ	1.0000000	0.844304	0.510203	ζ	0.518427	132.864	32.402	42.864	0.990765	$-9.2344\cdot10^{-3}$

Table 3
Various options of speed
addition at the particle horizon

With that I *believed* I had proven, that the correction factor ζ can be applied successfully both, in the microscopic, and even in the macroscopic scale. But we are also able to generate an exact solution variant using $RS=r_K/r_N$. It's a shame about variant 8. If correct, we would be able to calculate or even define the ratio m_e/m_p with the help of (141). Thus, it only suffices to a precision of $-2.74\cdot10^{-4}$, way too bad.

However, I was surprised, that version 9, that's *that* case, with which the real part of the wave function $\underline{c}_M$ (27) has a zero-crossing (phase-jump), delivers an acceptable result even without a correction factor. That suggests that there is also a correct solution without correction factor. I found it with version 12. Since it's the simplest variant, it's probably the right one and I will prioritize it.

The version depicted in [7], here 13, is quite near to variant 12 indeed. The representation is not that wrong there. Because table data is cropped, here the precise parameters for the prioritized variant 12:

$Q = 0.95013820167858442645$ $\quad c_M = 0.84854398252300 16\,c$ $\quad c_R = 0.529124852680352\,c$ $\quad c_K = 0.75\,c$

$\alpha = 134.86993657768931460°$ $\quad \beta = 31.94634370109298°$ $\quad \varphi = 44.8699365776893146°$ $\quad RS = 1.02469672804290424$

$$c = \sqrt{c_M^2 + c_K^2\cos^2\alpha} = c\sqrt{0.848544^2 + 0.529125^2} = 1.0000000c \qquad \Delta = \pm0.000000 \qquad (214)$$

RS applied to (213) turns out a deviation of $+2.74\cdot10^{-4}$. That's more than in case 6 indeed. In Figure 32 the case 12 with expression (214) is shown once again. We have clarified the contradictions between the various world radii and expansion velocities with it. With the help of the *Concerted International System of Units*, we were able to calculate a multitude of natural constants and variables. We will define it in detail in the next section.

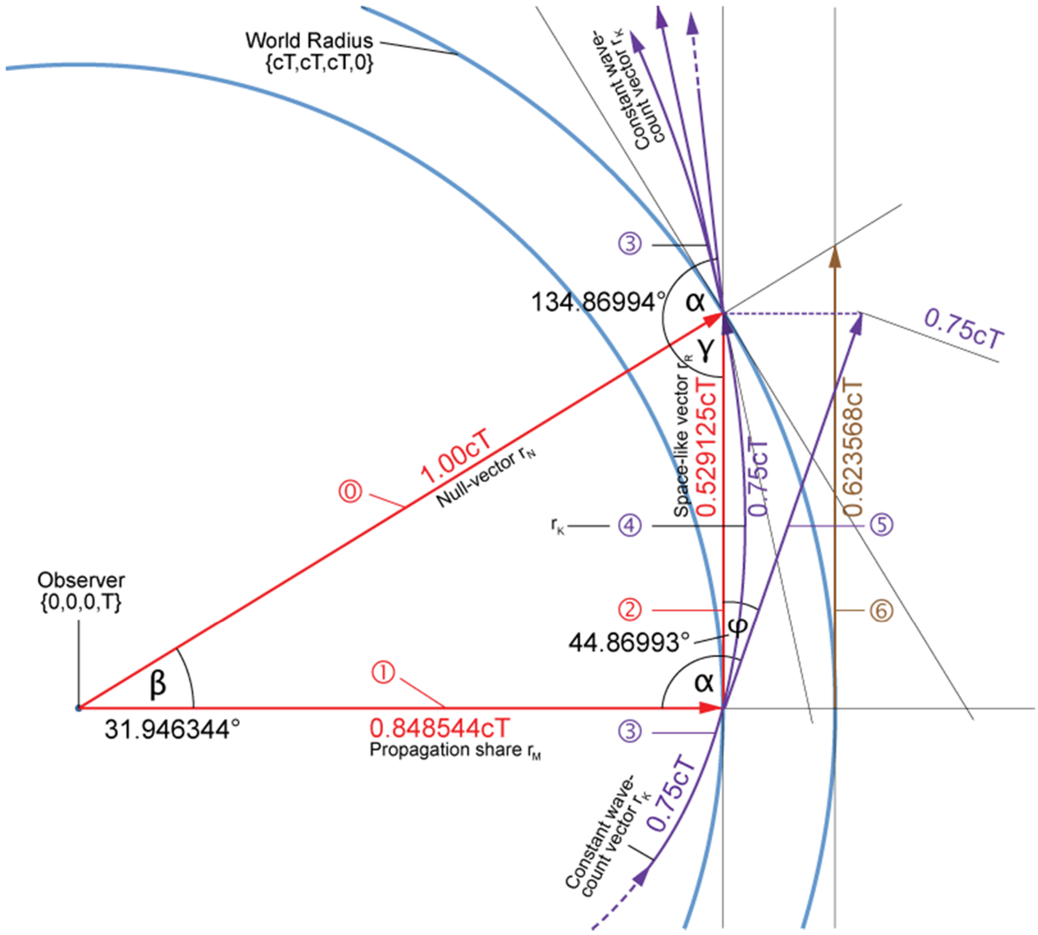

Figure 32
Expansion velocity and world radius
version 12 without correction factor

4. The Concerted International System of Units

With the help of this model we succeeded in the calculation of a whole slew of natural constants connected with the electron, proton and the ^{1}H-atom, by way of their relation to the frame of reference Q_0 and that perfectly exact. The maximum deviation of $\pm 1.0 \cdot 10^{-9}$ for the THOMSON cross section σ_e corresponds to the standard deviation of the numerical value given in Table [22]. Thus, the proof according to the Sudoku method is provided.

In fact, most values are not true constants. At the same time, the value of H_0 could be specified more precisely, as well as the value of κ_0, the specific conductivity of the vacuum, on which this model is based. Since we have uncovered the relations between the indi-vidual fundamental constants, it is appropriate to develop a program with which these are recalculated on the spot each time according to the reference system and to use it instead of a list of values determined independently of one another in different laboratories. With regard to the list, this would also have the advantage that the errors would not add up.

Thus, still remains to incorporate the results and relations into the program, already published in [1] and to compare the data calculated with it, with the $CODATA_{2018}$-values. The whole issue is presented in table 4. Please find the actualized program in the annex.

All is based on the base items of subspace, which are fixed values, independent on any frame of reference. With it, it suffices, to define five genuine constants (μ_0, c, κ_0, $\hbar_1$ and k) only as base quantities, plus one so-called *Magic Value*, here m_e, to the identification of the frame of reference Q_0.

The comparison with the $CODATA_{2018}$-values turns out to be more complicated, since not all values of the model appear in the corresponding documents. On the other hand, there are values stated, which, in comparison with other values, can be calculated with the help of former ones, lead to a deviant result. The PLANCK-units turned out to be the worst. The given values differ by up to $6.5\cdot10^{-8}$ from the ones calculated with c, ε_0, G and $\hbar$. However, according to the present model, the root expressions are considered to be exact. For this reason, I used at all PLANCK-units the corresponding root expressions with the $CODATA_{2018}$-values for c, ε_0, G and $\hbar$, instead of the specified numerical values to the comparison.

Furthermore, the use of the value m_e/m_p specified there leads to a reduction in accuracy. Therefore I used the quotient of the individual values. Another criticism is that a rounded value of the BOLTZMANN constant k is used.

With the PLANCK-temperature there is a further difference. Even if we can calculate such a value, the actual value is 0K, since thermal energy is completely eliminated by the angular momentum (see section 3.2.2.). The CMBR-temperature is considered instead. This depends on Q_0 too. If we rearrange (180) after Q_0, the frame of reference also depends on its temperature. With smaller Q_0, e.g. in the vicinity of the SCHWARZSCHILD-radius of a BH, the CMBR-temperature increases extremely.

There is also no addition of miscellaneous effects, such as temperature plus gravity in comparison to another frame of reference with the velocity v. All values are linked with Q_0, if one value changes, all other change too. If one effect supervenes, it is already a new frame of reference. Any additional effect changes the value of Q_0. With it all values, except for the fixed ones, form a so-called *Canonical Ensemble*.

During set-up of the table I incorporated yet some other values, simply dependent on the already defined ones, into the system, as there are σ_e, a_e, g_e, γ_e, μ_e, μ_N, Φ_0, G_0, K_J and R_K. Except for r_e, whose definition was wrong (eternal typo), I used the expressions and symbols stated in the $CODATA_{2018}$-document [22] for the other values. The quantities alpha (α) and delta (δ) are marked as fixed values because they are invariable in general. However, for special cases with $Q\approx1$ as in Section 3.2.2.2. there are the functions alphaF[Q] and deltaF[Q].

5. Notes to the appendix

The basic formulas and definitions used in this work, as well as the program to the calculation of Table 4, are shown in the appendix. The programs to the rendering of the graphics, which has been taken from previous publications, can be found in [6], [7] and [19]. It's about the source code for *Mathematica/Alpha*. Then, the data can be converted into a text file (UTF8), which can be opened directly. Data is presented as a single cell then. However, it is not advantageous to evaluate the entire source code in one single cell. To split, use the Cell/Divide Cell function (Ctrl/Shift/d). However, with this procedure there may be problems with special characters, not correctly transferred (e.g. ε, ϵ) or even lead to the conversion being aborted.

It is more advantageous to copy and paste data page by page into the text file via clipboard. However, then each line is present as a separate cell. With the command Cell/Merge (Ctrl/Shift/m) the cells belonging together can be merged, ideally in blocks between the headings.

If you do not want to calculate Table 4 and the graphics, you can delete the notebook below the point "End of Metric System Definition". Then, the values shown in the "Variable" column are available for own calculations. Expressions within (*…*) are commented out.

Suggestion to the reader: If one adds up all the errors in Table 4, it should be possible to achieve a minimum error by slightly manipulating κ_0, $\hbar_1$ und Q_0. Then all values should be calculated correctly.

Symbol	Variable	Calculated (CA)	Source	CODATA$_{2018}$ (CD) © COBE Data	± Accuracy	Δy (CA/CD–1)	Unit
c	c	$2.99792458 \cdot 10^{8}$	S	$2.99792458 \cdot 10^{8}$	defined	defined	$m\,s^{-1}$
ε_0	ep0	$8.854187817620390 \cdot 10^{-12}$	S	$8.854187817620390 \cdot 10^{-12}$	defined	defined	$As\,V^{-1}m^{-1}$
κ_0	ka0	$1.369777663190222 \cdot 10^{93}$	S	n.a.	n.a.	defined	$A\,V^{-1}m^{-1}$
μ_0	my0	$1.256637061435917 \cdot 10^{-6}$	S	$1.256637061435917 \cdot 10^{-6}$	exactly	exactly	$Vs\,A^{-1}m^{-1}$
k	k	$1.3806485279 \cdot 10^{-23}$	S	$1.380649 \cdot 10^{-23}$	statistic	$+3.41941 \cdot 10^{-7}$	$J\,K^{-1}$
$\hbar_1$	hb1	$8.795625796565460 \cdot 10^{26}$	S	n.a.	n.a.	defined	J s
$\hbar$	hb0	$1.054571817000010 \cdot 10^{-34}$	C	$1.054571817 \cdot 10^{-34}$	defined	$+8.88178 \cdot 10^{-15}$	J s
Q_0	Q0	$8.340471132242850 \cdot 10^{60}$	C	$8.3415 \cdot 10^{60}$ ©	$3.3742 \cdot 10^{-2}$	$-1.23343 \cdot 10^{-4}$	1
Z_0	Z0	376.7303134617700	F	376.73031366857	$1.5 \cdot 10^{-10}$	$-5.48932 \cdot 10^{-10}$	Ω
G	G0	$6.674301499999827 \cdot 10^{-11}$	C	$6.674301499999999 \cdot 10^{-11}$	$2.2 \cdot 10^{-5}$	$-5.48932 \cdot 10^{-10}$	$m^3kg^{-1}s^{-2}$
G_1	G1	$9.594550966819210 \cdot 10^{-133}$	C	n.a.	n.a.	unusual	$m^3kg^{-1}s^{-2}$
G_2	G2	$1.150360790738584 \cdot 10^{-193}$	F	n.a.	n.a.	unusual	$m^3kg^{-1}s^{-2}$
M_2	M2	$1.514002834704114 \cdot 10^{114}$	F	n.a.	n.a.	unusual	kg
M_1	M1	$1.815248576128075 \cdot 10^{53}$	C	n.a.	n.a.	unusual	kg
m_p	mp	$1.6726219236951 \cdot 10^{-27}$	C	$1.6726219236951 \cdot 10^{-27}$	$1.1 \cdot 10^{-5}$	$-2.22045 \cdot 10^{-16}$	kg
m_e	me	$9.109383701528 \cdot 10^{-31}$	M	$9.109383701528 \cdot 10^{-31}$	$3.0 \cdot 10^{-10}$	magic ±0	kg
m_0	m0	$2.176434097482374 \cdot 10^{-8}$	C	$2.176434097482336 \cdot 10^{-8}$	calculated	$+1.70974 \cdot 10^{-14}$	kg
M_H	MH	$2.609485798792167 \cdot 10^{-69}$	C	n.a.	n.a.	unusual	kg
m_e/m_p	mep	$5.446170214846793 \cdot 10^{-4}$	F	$5.4461702148733 \cdot 10^{-4}$	$6.0 \cdot 10^{-11}$	$-4.867 \cdot 10^{-12}$	1
T_p	Tp	0.000000000000000	C	$1.416784486973588 \cdot 10^{32}$	calculated	MOOP	K
T_{k1}	Tk1	$5.475357175411492 \cdot 10^{152}$	C	n.a.	n.a.	unusual	K
T_k	Tk0	2.725436049425770	C	2.72548 ©	$4.3951 \cdot 10^{-5}$	$-1.61258 \cdot 10^{-5}$	K
r_1	r1	$1.937846411698606 \cdot 10^{-96}$	F	n.a.	n.a.	unusual	m
r_0	r0	$1.616255205549261 \cdot 10^{-35}$	C	$1.616255205549274 \cdot 10^{-35}$	calculated	$-8.21565 \cdot 10^{-15}$	m
r_e	re	$2.817940324662071 \cdot 10^{-15}$	C	$2.817940326213 \cdot 10^{-15}$	$4.5 \cdot 10^{-10}$	$-5.50377 \cdot 10^{-10}$	m
$\bar{\lambda}_C$	ΛbarC	$3.861592677230890 \cdot 10^{-13}$	C	$3.861592679612 \cdot 10^{-13}$	$3.0 \cdot 10^{-10}$	$-6.16614 \cdot 10^{-10}$	m
λ_C	ΛC	$2.426310237188940 \cdot 10^{-12}$	C	$2.4263102386773 \cdot 10^{-12}$	$3.0 \cdot 10^{-10}$	$-6.13425 \cdot 10^{-10}$	m
a_0	a0	$5.291772105440689 \cdot 10^{-11}$	C	$5.291772109038 \cdot 10^{-11}$	$1.5 \cdot 10^{-10}$	$-6.79793 \cdot 10^{-10}$	m
R	R	$1.348032988422084 \cdot 10^{26}$	C	n.a.	at issue	at issue	m
R	RR	4.368617335409830	C	n.a.	at issue	at issue	Gpc
t_1	2 t1	$6.463959849512312 \cdot 10^{-105}$	F	n.a.	n.a.	unusual	s
t_0	2 t0	$5.391247052483426 \cdot 10^{-44}$	C	$5.391247052483470 \cdot 10^{-44}$	calculated	$-8.43769 \cdot 10^{-15}$	s
T	2 T	$4.496554040802734 \cdot 10^{17}$	C	$4.497663485280829 \cdot 10^{17}$	$1.1385 \cdot 10^{-3}$	$-2.46671 \cdot 10^{-4}$	s
T	2 T	$1.424902426903056 \cdot 10^{10}$	C	$1.425253996152531 \cdot 10^{10}$	$1.1385 \cdot 10^{-3}$	$-2.46671 \cdot 10^{-4}$	a
R_∞	R∞	$1.097373157632934 \cdot 10^{7}$	C	$1.097373156816021 \cdot 10^{7}$	$1.9 \cdot 10^{-12}$	$+7.44426 \cdot 10^{-10}$	m^{-1}
ω_1	Om1	$1.547039312249824 \cdot 10^{104}$	F	n.a.	n.a.	unusual	s^{-1}
ω_0	Om0	$1.854858421929227 \cdot 10^{43}$	C	$1.854858421929212 \cdot 10^{43}$	calculated	$+8.65974 \cdot 10^{-15}$	s^{-1}
$\omega_{R\infty}$	OmR∞	$2.067068668297942 \cdot 10^{16}$	C	$2.067068666759112 \cdot 10^{16}$	$1.9 \cdot 10^{-12}$	$+7.44451 \cdot 10^{-10}$	s^{-1}
cR_∞	cR∞	$3.289841962699988 \cdot 10^{15}$	C	$3.289841960250864 \cdot 10^{15}$	$1.9 \cdot 10^{-12}$	$+7.44450 \cdot 10^{-10}$	Hz
H_0	H0	$2.223925234581364 \cdot 10^{-18}$	C	$2.223376656062923 \cdot 10^{-18}$	$1.1385 \cdot 10^{-3}$	$+2.46732 \cdot 10^{-4}$	s^{-1}
H_0	HPC[Q0]	68.62410574852400	C	68.60717815146482←↑©	$1.1385 \cdot 10^{-3}$	$+2.46732 \cdot 10^{-4}$	$kms^{-1}Mpc^{-1}$
q_1	q1	$1.527981474087040 \cdot 10^{12}$	F	n.a.	n.a.	unusual	As
q_0	q0	$5.290817689717126 \cdot 10^{-19}$	C	$5.2908176897171 \cdot 10^{-19}$	calculated	$+4.44089 \cdot 10^{-15}$	As
e	qe	$1.602176634000007 \cdot 10^{-19}$	C	$1.602176634 \cdot 10^{-19}$	exactly	$+4.44089 \cdot 10^{-15}$	As
U_1	U1	$8.698608435529670 \cdot 10^{87}$	F	n.a.	n.a.	unusual	V
U_0	U0	$1.042939697003725 \cdot 10^{27}$	C	$1.042939697286845 \cdot 10^{27}$	calculated	$-2.71463 \cdot 10^{-10}$	V
W_1	W1	$1.360717888312544 \cdot 10^{131}$	F	n.a.	n.a.	unusual	W
W_0	W0	$1.956081416291675 \cdot 10^{9}$	C	$1.956081416291641 \cdot 10^{9}$	calculated	$+1.73195 \cdot 10^{-14}$	W
S_1	S1	$5.605711433987692 \cdot 10^{426}$	F	n.a.	n.a.	unusual	Wm^{-2}
S_0	S0	$1.388921881877266 \cdot 10^{122}$	C	n.a.	n.a.	unusual	Wm^{-2}
σ_e	σe	$6.652458724888907 \cdot 10^{-29}$	C	$6.6524587321600 \cdot 10^{-29}$	$9.1 \cdot 10^{-10}$	$-1.09299 \cdot 10^{-9}$	m^2
a_e	ae	$1.159652181281556 \cdot 10^{-3}$	C	$1.1596521812818 \cdot 10^{-3}$	$1.5 \cdot 10^{-10}$	$-2.10054 \cdot 10^{-13}$	1
g_e	ge	−2.00231930436256	C	−2.00231930436256	$1.7 \cdot 10^{-13}$	$-2.22045 \cdot 10^{-16}$	1
γ_e	γe	$1.760859630228709 \cdot 10^{11}$	C	$1.7608596302353 \cdot 10^{11}$	$3.0 \cdot 10^{-10}$	$-3.74278 \cdot 10^{-12}$	$s^{-1}T^{-1}$
μ_e	μe	$-9.28476469866128 \cdot 10^{-24}$	C	$-9.284764704328 \cdot 10^{-24}$	$3.0 \cdot 10^{-10}$	$-6.10325 \cdot 10^{-10}$	JT^{-1}

Symbol	Variable	Calculated (CA)	Source	$CODATA_{2018}$ (CD) © COBE Data	± Accuracy	Δy (CA/CD–1)	Unit
μ_B	μB	$-9.27401007265130 \cdot 10^{-24}$	C	$-9.274010078328 \cdot 10^{-24}$	$3.0 \cdot 10^{-10}$	$-6.12109 \cdot 10^{-10}$	JT^{-1}
μ_N	μN	$5.050783742986264 \cdot 10^{-27}$	C	$5.0507837461150 \cdot 10^{-27}$	$3.1 \cdot 10^{-10}$	$-6.19456 \cdot 10^{-10}$	JT^{-1}
Φ_0	Φ0	$2.067833847194937 \cdot 10^{-15}$	C	2.067833848 .... $\cdot 10^{-15}$	exactly	$-3.89327 \cdot 10^{-10}$	Wb
G_0	GQ0	$7.748091734611053 \cdot 10^{-5}$	C	$7.748091729000002 \cdot 10^{-5}$	exactly	$+7.24185 \cdot 10^{-10}$	S
K_J	KJ	$4.835978487132911 \cdot 10^{14}$	C	4.835978484 .... $\cdot 10^{14}$	exactly	$+6.47834 \cdot 10^{-10}$	HzV^{-1}
R_K	RK	$2.581280744348851 \cdot 10^{4}$	C	2.581280745 .... $\cdot 10^{4}$	exactly	$-2.52258 \cdot 10^{-10}$	Ω
α	alpha	$7.297352569776440 \cdot 10^{-3}$	F	$7.297352569311 \cdot 10^{-3}$	$1.5 \cdot 10^{-10}$	$+6.37821 \cdot 10^{-11}$	1
δ	delta	$9.378551014802563 \cdot 10^{-1}$	F	$9.378551009654370 \cdot 10^{-1}$	$1.5 \cdot 10^{-10}$	$+5.48932 \cdot 10^{-10}$	1
$\tilde{x}$	xtilde	2.821439372122070`	F	2.821439372	exactly	exactly	1
σ	σ	$5.670366673885495 \cdot 10^{-8}$	C	$5.670366673885496 \cdot 10^{-8}$	exactly	exactly	$Wm^{-2}K^{-4}$

S Subspace value (const) M Magic value MachinePrecision → $\pm 2.22045 \cdot 10^{-16}$
F Fixed value (invariable) C Calculated (calculated) MOOP Matter of Opinion

Table 4:
Concerted International
System of Units

Unfortunately not all values could be calculated, e.g. the values of other elementary particles and the ones of heavier nuclei. A lot of questions remain open. Also the values aren't *concerted* to 100%, i.e. even my system is yet a little bit *out of tune*. But there is the option to improve it.

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The Concerted International System of Units

Declarations

```
Off[InterpolatingFunction::dmval]
Off[FindRoot::nlnum]
Off[General::Spell]
Off[Greater::nord]
Off[Power::infy]
```

Units

```
km=1000;
Mpc=3.08572*10^19 km;
minute=60;
hour=60 minute;
day=24*hour;
year=365.24219879*day;
MS=1.98840*10^30;
RS=6.96342*10^8 ;
ME=5.9722*10^24;
RE=6.371000785*10^6;
```

Basic Values

```
c=2.99792458*10^8;                                              (*Speed of light*);
my0=4 Pi 10^-7;                                         (*Permeability of vacuum*);
ka0=1.3697776631902217*10^93;                           (*Conductivity of vacuum*);
hb1=8.795625796565464*10^26;                      (*Planck constant slashed init*);
k=1.3806485279*10^-23;                                     (*Boltzmann constant*);
me=9.109383701528*10^-31;                (*Electron rest mass with Q0 Magic value 1*);
mp=1.6726219236951*10^-27;                        (*Proton rest mass Magic value 2*);
```

Auxilliary Values

```
mep=SetPrecision[me/mp,20];                                      (*Mass ratio e/p*);
ma=1822.8884862171988 me;                                      (*Atomic mass unit*);
ϵ=ArcSin[0.3028221208819742993334500624769134447]-3Pi/4;    (*RnB angle ϵ null(fix)*);
γ=Pi/4-ϵ;                                               (*RnB angle γ nullvector*);
ζ=1/(36Pi^3)(3Sqrt[2])^(-1/3)/mep;                        (*re-correction factor*);
xtilde=3+N[ProductLog[-3E^-3]];                (*Wien displacement law constant (ν)*);
alpha=Sin[Pi/4-\[Epsilon]]^2/(4Pi);            (*Correction factor QED \[Alpha](Q0)*);
delta=4Pi/alpha*mep;                           (*Correction factor QED \[Delta](Q0)*);
(*Q0=(9Pi^2 Sqrt[2]delta me/my0/ka0/hb0SI)^(-3/4)  (*Phase Q0=2ω0t during calibration*);*)
Q0=(9 Pi^2 Sqrt[2]delta me/my0/ka0/hb1)^(-3/7);   (*Phase Q0=2ω0t after calibration*);
```

Composed Expressions

```
Z0=my0 c;                                           (*Field wave impedance of vacuum*);
ep0=1/(my0 c^2)                                           (* Permittivity of vacuum*);
R∞=1/(72 Pi^3)/r1 Sqrt[2] alpha^2 /delta Q0^(-4/3);                (*Rydberg constant*);
Om1=ka0/ep0;                                         (*Cutoff frequency of subspace*);
Om0=Om1/Q0;                                                   (*Planck's frequency*);
OmR∞=2 Pi c R∞;                                       (*Rydberg angular frequency*);
cR∞=c R∞;                                                    (*Rydberg frequency*);
H0=Om1/Q0^2;                                             (*Hubble parameter local*);
H1=3/2*H0;                                      (*Hubble parameter whole universe*);
r1=1/(ka0 Z0);                                          (*Planck's length subspace*);
a0=9Pi^2 r1 Sqrt[2] delta/alpha Q0^(4/3);                             (*Bohr radius*);
ΛbarC=a0 alpha;                                       (*Reduced Compton wavelength*);
ΛC=2 Pi ΛbarC;                                       (*Compton wavelength electron*);
re= r1 (2/3)^(1/3)/ζ Q0^(4/3);                            (*Classic electron radius*);
r0= r1 Q0;                                                   (*Planck's length vac*);
R= r1 Q0^2;                                                         (*World radius*);
RR=R/Mpc/1000;                                                  (*World radius Gpc*);
t1=1/(2 Om1);                                             (*Planck time subspace*);
t0=1/(2 Om0);                                                 (*Planck time vacuum*);
```

```
T=1/(2 H0);                                                    (*World time constant*);
TT=2T/year;                                                           (*The Age*);

hb0=hb1/Q0;                                               (*Planck constant slashed*);
h0=2Pi*hb0;                                             (*Planck constant unslashed*);
q1=Sqrt[hb1/Z0];                                                 (*Universe charge*);
q0=Sqrt[hb1/Q0/Z0];                              (*or qe/Sin[π/4-ϵ] Planck charge*);
qe=q0 Sin[Pi/4-ϵ];                                           (*Elementary charge e*);
M2=my0 ka0 hb1;                                              (*Total mass with Q=1*);
M1=M2/Q0;                                                               (*Mach mass*);
m0=M2/Q0^2;                                                (*Planck mass downwardly*);
(*m0=(9Pi^2Sqrt[2]*delta*me)^.75*(my0*ka0*hb0SI)^.25;        (*Planck mass upwardly*);*)
mp=4Pi me/alpha/delta;                                   (*Proton rest mass with Q0*);
(*me=Sqrt[hb1/Q0/Z0]*Sin[Pi/4-ϵ];                      (*if using Q0 as Magic value*);*)
MH=M2/Q0^3;                                                           (*Hubble mass*);
G0=c^2*r0/m0; (*hb0*c/m0^2*)                               (*Gravity constant local*);
G1=G0/Q0^2;                                                 (*Gravity constant Mach*);
G2=G0/Q0^3;                                                 (*Gravity constant Init*);
U0=Sqrt[c^4/4/Pi/ep0/G0];                                  (*Planck voltage generic*);
U1=U0*Q0;                                                     (*Planck voltage Mach*);
W1=Sqrt[hb1 c^5/G2];                                             (*Energy with Q=1*);
W0=W1/Q0^2;                                                         (*Planck energy*);
S1=hb1 Om1^2/r1^2;                                (*Poynting vector metric with Q=1*);
S0=S1/Q0^5;                                          (*Poynting vector metric actual*);
Sk1=4Pi^2*E^2/18^4/60*hb1*Om1^2/r1^2;                                (*Poyntingvec CMBR
initial*);
Sk0=Sk1/Q0^4/Q0^3/E^2;                                               (*Poyntingvec CMBR
actual*);
wk1=Sk1/c ;                                                     (*Energy density CMBR
initial*);
wk0=Sk0/c ;                                                     (*Energy density CMBR
actual*);
Wk1=wk1*r1^3;                                                           (*Energy CMBR
initial*);
μB=-9/2Pi^2 Sqrt[2 hb1/Z0]delta Sin[γ]/my0/ka0 Q0^(5/6);             (*Bohr magneton*);
μN=-μB*mep;                                                      (*Nuclear magneton*);
μe=1.0011596521812818 μB                                 (*Electron magnetic moment*);
Tk1=hb1 Om1/18/k;                                            (*CMBR-temperature Q=1*);
Tk0=Tk1/Q0^(5/2);                                                (*CMBR-temperature*);
Tp0=0.; Tp1=0.;                                                (*Planck-temperature*);
Φ0=Pi Sqrt[hb1 Z0/Q0 ]/Sin[Pi/4-ϵ];                (*Magnetic flux quantum Pi ħ/e)*);
GQ0=1/Pi/Z0*Sin[Pi/4-ϵ]^2;                         (*Conductance quantum e^2/Pi ħ*);
KJ=2q0 Sin[Pi/4-ϵ]/h0;                                 (*Josephson constant 2e/h*);
RK=.5 my0 c/alpha;                                 (*von Klitzing constant μ0c/2α*);
σe=8Pi/3 re^2;                                (*Thomson cross section (8Pi/3)re^2*);
ae=SetPrecision[μe/μB,20]-1;                     (*Electron magnetic moment anomaly*);
ge=-2(1+ae);                                                    (*electron g-factor*);
γe=2 Q0 Abs[μe]/hb1;                                  (*electron gyromagnetic ratio*);
σ1= SetPrecision[Pi^2/60  k^4/c^2/hb1^3,  16];          (*Stefan-Boltzmann  constant
initial*);
σ=σ1*Q0^3;                                                (*Stefan-Boltzmann constant*);
```

Basic Functions

```
cMc=Function[-2 I/#/Sqrt[1-(HankelH1[2,#]/HankelH1[0,#])^2]];
Qr=Function[#1/Q0/2/#2];
PhiQ=Function[If[#>10^4,-Pi/4-3/4/#,
Arg[1/Sqrt[1-(HankelH1[2,#]/HankelH1[0,#])^2]]-Pi/2]];        (*Angle of c arg θ(Q)*);
PhiR=Function[PhiQ[Qr[#1,#2]]];
RhoQ=Function[If[#<10^4,N[2/#/Abs[Sqrt[1-
(HankelH1[2,#]/HankelH1[0,#])^2]]],1/Sqrt[#]]];
RhoR=Function[RhoQ[Qr[#1,#2]]];
AlphaQ=Function[Pi/4-PhiQ[#]];                                            (*Angle α*);
AlphaR=Function[N[Pi/4-PhiR[#1,#2]]];
BetaQ=Function[Sqrt[#1]*((#2)^2+#1^2*(1-(#2)^2)^2)^(-.25)];
GammaPQ=Function[N[PhiQ[#]+ArcCos[RhoQ[#]*Sin[AlphaQ[#]]]+Pi/4]];
rq={{0,0}};
For[x=-8;i=0,x<4,++i,x+=.01;AppendTo[rq,{10^x,N[10^x*RhoQ[10^x]]}]];
RhoQ1=Interpolation[rq];
RhoQQ1=Function[If[#<10^3,RhoQ1[#],Sqrt[#]]];                  (*Interpolation RhoQ*);
```

```
Rk=Function[If[#<10^5,3/2*Sqrt[#]*NIntegrate[RhoQQ1[x],{x,0,#}],6#]];
Rn=Function[Abs[3/2*Sqrt[#]*NIntegrate[RhoQQ1[x]*Exp[I*(PhiQ[x])],{x,0,#}]]];
RnB=Function[Arg[NIntegrate[RhoQQ1[x]*Exp[I*(PhiQ[x])],{x,0,#}]]];
alphaF=Function[Sin[Pi/2+ϵ-RNBP[#]]^2 /(4Pi)];          (*Correction factor QED α(Q)*);
deltaF=Function[4Pi/alphaF[#]*mep];                      (*Correction factor QED δ(Q)*);
```

End of Metric System Definition

Functions Used for Calculations in Articles

```
GV=Function[Graphics[Line[{{#1,#2},{#1,#3}}]]];              (*Graphics help function*);
GH=Function[Graphics[Line[{{#2,#1},{#3,#1}}]]];              (*Graphics help function*);
Xline=Function[10^33*(#1-#2)];                                 (*Value_x vertical line*);
Expp=Function[If[#<0,1/Exp[-#],Exp[#]]];                  (*To avoid calculation errors*);

BRQP=Function[Rk[#]                    Sqrt[(Sin[AlphaQ[#]]/Sin[GammaPQ[#]])^4-1]];
BGN=Sqrt[2]*BRQP[.5]/3;

gdc=Function[10^(Log10[E]*(-1) (1*#)^2/(1 + 1*#^2)^2)];    (*Group Delay Correction*);
cc = xtilde^2;
b=xtilde;
s1 = 8*(#1/(2*((#1/2)^2 + 1)))^2 & ;
s2 =  (b*(#1/2))^3/(Expp [b*(#1/2)] - 1) & ;
brq = {{0, 0}};
For[x = -8; i = 0, x < 50, (++i), x += .05;
 AppendTo[brq, {10^x, N[BRQP[10^x]/BGN/(2.5070314770581117*10^x) ]}]]
BRQ0 = Interpolation[brq];
BRQ1 = Function[If[# < 8*10^4, BRQ0[#], Sqrt[#]]];
Psi1 = NIntegrate[(1/2)*Log[1 + (#1/(cc*Sqrt[Q]))^2] -
      ((#1/(cc*Sqrt[Q]))^2)/(1 + (#1/(cc*Sqrt[Q]))^2) -
      Log[Cos[-ArcTan[#1/(cc*Sqrt[Q])] +
         #1/(cc*Sqrt[Q])/(1 + (#1/(cc*Sqrt[Q]))^2)]],
     {Q, 0.5, 3000}] & ;                                             (*Approximation*);
Psi2 = NIntegrate[(1/2)*Log[1 + (#1/(cc*BRQ1[Q]))^2] -
      ((#1/(cc*BRQ1[Q]))^2)/(1 + (#1/(cc*BRQ1[Q]))^2) -
      Log[Cos[-ArcTan[#1/(cc*BRQ1[Q])] +
         #1/(cc*BRQ1[Q])/(1 + (#1/(cc*BRQ1[Q]))^2)]],
     {Q, 0.5, 3000}] & ;                                                    (*Exact ξ*);
HPC=Function[Om1/#^2/km*Mpc];                               (*H0=f(Q0)[km*s-1*Mpc-1]*);
Qv=Function[a4712=SetPrecision[#2,309];#1*(1-a4712^2)^(1/3)];       (*Q(v/c) generic*);
Qv0=Function[a4713=SetPrecision[#,309];Q0*(1-a4713^2)^(1/3)];          (*Q(v/c, Q0)*);
vQ=Function[a4714=SetPrecision[(#2/#1)^3,309];
Sqrt[SetPrecision[1-a4714,309]]];                                   (*v/c(Q) generic*);
vQ0=Function[a4715=SetPrecision[(#/Q0)^3,309];
Sqrt[SetPrecision[1-a4715,309]]];                                        (*v/c(Q0), Q0)*);
Q890=3/2*(re/r0)^3 ;                                          (*Phase angle/(890 [1])*);
VrelU=Function[ScientificForm[SetPrecision[Sqrt[1-SetPrecision[1/
(1+# qe/me/c^2)^2,180]],180]180]];                                     (*vrel(U)/c*);
DVrelU=Function[ScientificForm[SetPrecision[1-(Sqrt[1-SetPrecision[1/
(1+# qe/me/c^2)^2,180]]),180],10]];                                  (*1-vrel(U)/c*);
QrelU=Function[SetPrecision[SetPrecision[1/
(1+# qe/me/c^2)^(2/3),180],16]];                                        (*Qrel(U)/Q0*);
QQrelU=Function[Q0*(QrelU[#])];                                            (*Qrel(U)*);
UeV=Function[a4711=SetPrecision[#,1000];
(me c^2(1/Sqrt[1-a4711^2]-1))/qe];                                         (*U(v)309*);
```

Helpful Interpolations

Not really needed. Evaluate only once the lines below the upper lines, then store data in e.g. rs={data} and close the cells. Evaluation can take a while. Don' t delete but always evaluate them. Disable evaluation for the lines below the upper line until Interpolation line then. Save notebook.

```
rs={"Insert output from below"};
rs={};
For[x=(-3);                                              i=0,x<3,(++i),x+=.025;
AppendTo[rs,{10^x,NIntegrate[RhoQQ1[z],{z,0,10^x}]/Abs[NIntegrate[RhoQQ1[z]*
Exp[I/2*ArgThetaQ[z]],{z,0,10^x}]]}]]
rs
```

```
RS=Interpolation[rs];                                          (*Relation rk/rn*);
RS1=Function[1/RS[#]];
```

```
rnb={"Insert output from below"};
rnb={};
For[d=-6.01; i=0,d<6.01,(++i),d+=.05; AppendTo[rnb,{d,RnB[10^d]/Pi}]]
rnb

RNB1=Interpolation[rnb];                        (*RnB angle ϵ nullvector from Q*);
RNB=Function[If[#<10^-8,Null,If[#<10^6,RNB1[Log10[#]],-.25]]];
RNBP=Function[If[#<10^-8,Null,If[#<10^6,Pi RNB1[Log10[#]],-Pi/4]]];
```

```
qq1={"Insert output from below"};
qq1={};
For[xy=(-17);        i=0,xy<5,(++i),xy+=.05;        AppendTo[qq1,{10^xy,N[Sin[(Pi/2-
RnB[10^xy]+ϵ)]]}]]
qq1

QQ0=Interpolation[qq1];                                        (*Relation qe/q0*);
QQ=Function[If[#<10^5,QQ0[#],0.3028223504900885]];
QQ1=Function[If[#<10^5,1/QQ0[#],3.3022661582990733]];
```

```
inb={"Insert output from below"};
inb={};
For[d=-6.01; i=0,d<6.01,(++i),d+=.05; AppendTo[inb,{RnB[10^d]/Pi,d}]]
inb

INB1=Interpolation[inb];                     (*InvRnB Q from angle ϵ nullvector*);
INB=Function[Which[-1<#<0,INB1[#],#==0,3/2Pi Q0^.25,#>0,Null]];
INBP=Function[Which[-Pi<#<0,INB1[#/Pi],#==0,3/2 Q0^.25,#>0,Null]];
```

Reference Values CODATA$_{2018}$ to the Comparison only

```
hb0SI=1.054571817*10^-34;                                   (*Planck constant slashed*);
h0SI=6.62607015*10^-34;                                   (*Planck constant unslashed*);
ep0SI=8.854187812813*10^-12;                                  (*Permittivity of vacuum*);
kSI=1.380649*10^-23;                                          (*Boltzmann-constant*);
G0SI=6.6743015*10^-11;                                         (*Gravity constant *);
ka0SI=1.30605*10^93;                            (*1.3057 Conductivity of vacuum*);
qeSI=1.602176634*10^-19;                                    (*Elementary charge e*);
q0SI=Sqrt[hb0SI/Z0];                                            (*Planck-charge*);
meSI=9.109383701528*10^-31;                            (*Electron rest mass with Q0*);
mpSI=1.6726219236951*10^-27;                                    (*Proton rest mass*);
alphaSI=7.297352569311*10^-3;                               (*Fine structure constant*);
deltaSI=(4Pi)^2 hb0SI/Z0SI/qeSI^2 *meSI/mpSI;                          (*Factor QED*);
mnSI=1.6749274980495*10^-27;                                   (*Neutron rest mass*);
maSI=1.6605390666050*10^-27;                                    (*Atomic mass unit*);
mepSI=5.4461702148733*10^-4;                                      (*Mass ratio e/p*);
m0SI=Sqrt[hb0SI c/G0SI](*2.17643424*10^-8 garbage*);                   (*Planck-mass*);
r0SI=hb0SI/m0SI/c(*1.61625518*10^-35 garbage*);                     (*Planck-length*);
t0SI=.5Sqrt[hb0SI G0SI/c^5](*5.39124760*10^-44 garbage*);              (*Planck-time*);
Φ0SI=2.067833848*10^-15;                          (*Magnetic flux quantum 2Piħ/(2e)*);
GQ0SI=7.748091729*10^-5;                            (*Conductance quantum 2e^2/2Piħ*);
U0SI= Sqrt[c^4/(4 Pi ep0SI G0SI)](*1.04295*10^27 garbage*);        (*Planck-voltage*);
U1SI=U0SI Q0;                                             (*Planck-voltage universe*);
W0SI=Sqrt[hb0SI c^5/G0SI];                                          (*Planck-energy*);
TpSI=SetPrecision[Sqrt[hb0SI c^5/G0SI]/k,16]  (*1.41678416*10^32 Planck-temperature*);
TCOBE=2.72548;                                    (*±0.00057K CMBR-temperature/COBE*);
Z0SI=376.73031366857;                              (*Field wave impedance of vacuum*);
KJSI=483597.8484*10^9;                                   (*Josephson constant 2e/h*);
RKSI=25812.80745;                                  (*von Klitzing constant µ0c/2α*);
µBSI=-9.274010078328*10^-24;                                        (*Bohr Magneton*);
µNSI=5.050783746115*10^-27;                                      (*Nuclear magneton*);
R∞SI=1.097373156816021*10^7;                                     (*Rydberg constant*);
cR∞SI=3.289841960250864*10^15;                                  (*Rydberg frequency*);
```

```
OmR∞SI=2Pi*cR∞SI;                                           (*Rydberg angular frequency*);
a0SI=5.2917721090380*10^-11;                                              (*Bohr radius*);
reSI=2.817940326213*10^-15;                                 (*Classical electron radius*);
ΛCSI=2.4263102386773*10^-12;                              (*Compton wavelength electron*);
ΛbarCSI=3.861592679612*10^-13;                             (*Reduced Compton wavelength*);
σeSI=6.652458732160*10^-29;                      (*Thomson cross section (8Pi/3)re^2*);
μeSI=-9.284764704328*10^-24;                               (*electron magnetic moment*);
aeSI=1.1596521812818*10^-3;                         (*Electron magnetic moment anomaly*);
geSI=-2.0023193043625635;                                         (*electron g-factor*);
γeSI=1.7608596302353*10^11;                               (*electron gyromagnetic ratio*);
σSI=5.670366673885496*10^-8;                               (*Stefan-Boltzmann constant*);
QCB=8.3415*10^60;                                                  (*Phase angle COBE*);
```

Calculating Table 4

```
data={
{"c",ScientificForm[c,16],ScientificForm[c,16], "defined"},
{"ep0",ScientificForm[N[ep0],16],ScientificForm[N[ep0],16], "defined"},
{"ka0",ScientificForm[N[ka0],16],"n.a.", "defined"},
{"my0",ScientificForm[N[my0],16],ScientificForm[N[my0],16], "exactly"},
{"k",ScientificForm[N[k],16],ScientificForm[kSI,16],
 ScientificForm[kSI/k-1,NumberSigns->{"-","+"}]},
{"hb1",ScientificForm[hb1,16],"n.a.", "defined"},
{"hb0",ScientificForm[hb0,16],ScientificForm[hb0SI,16],
 ScientificForm[hb0/hb0SI-1,NumberSigns->{"-","+"}]},
{"Q0",ScientificForm[Q0,16],ScientificForm[QCB,16],
 ScientificForm[Q0/QCB-1,NumberSigns->{"-","+"}]},
{"Z0 ",NumberForm[Z0,16],NumberForm[Z0SI,16],
 ScientificForm[Z0/Z0SI-1,NumberSigns->{"-","+"}]},
{"G0 ",ScientificForm[G0,16],ScientificForm[G0SI,16],
 ScientificForm[Z0/Z0SI-1,NumberSigns->{"-","+"}]},
{"G1 ",ScientificForm[G1,16],"n.a.","unusual"},
{"G2 ",ScientificForm[G2,16],"n.a.","unusual"},
{"M2",ScientificForm[M2,16],"n.a.","unusual"},
{"M1",ScientificForm[M1,16],"n.a.","unusual"},
{"mp",ScientificForm[mp,16],ScientificForm[mpSI,16],
 ScientificForm[mp/mpSI-1,NumberSigns->{"-","+"}]},
{"me",ScientificForm[me,16],ScientificForm[meSI,16], "magic±0"},
{"m0",ScientificForm[m0,16],ScientificForm[m0SI,16],
 ScientificForm[m0/m0SI-1,NumberSigns->{"-","+"}]},
{"MH",ScientificForm[MH,16],"n.a.","unusual"},
{"mep",ScientificForm[mep,16],ScientificForm[mepSI,16],
 ScientificForm[mep/mepSI-1,NumberSigns->{"-","+"}]},
{"Tp",NumberForm[Tp0,16],ScientificForm[TpSI,16], "MOOP"},
{"Tk1",ScientificForm[Tk1,16],"n.a.","unusual"},
{"Tk0",NumberForm[Tk0,16],ToString[NumberForm[TCOBE,16]]<>" ©",
 ScientificForm[Tk0/TCOBE-1,NumberSigns->{"-","+"}]},
{"r1",ScientificForm[r1,16],"n.a.","unusual"},
{"r0",ScientificForm[r0,16],ScientificForm[r0SI,16],
 ScientificForm[r0/r0SI-1,NumberSigns->{"-","+"}]},
{"re",ScientificForm[re,16],ScientificForm[reSI,16],
 ScientificForm[re/reSI-1,NumberSigns->{"-","+"}]},
{"ΛbarC",ScientificForm[ΛbarC,16],ScientificForm[ΛbarCSI,16],
 ScientificForm[ΛbarC/ΛbarCSI-1,NumberSigns->{"-","+"}]},
{"ΛC",ScientificForm[ΛC,16],ScientificForm[ΛCSI,16],
 ScientificForm[ΛC/ΛCSI-1,NumberSigns->{"-","+"}]},
{"a0",ScientificForm[a0,16],ScientificForm[a0SI,16],
 ScientificForm[a0/a0SI-1,NumberSigns->{"-","+"}]},
{"R     [m]",ScientificForm[R,16],"n.a.","at issue"},
{"R   [Gpc]",ScientificForm[RR,16],"n.a.","at issue"},
{"2t1",ScientificForm[2t1,16],"n.a.","unusual"},
{"2t0",NumberForm[2t0,16],NumberForm[2t0SI,16],
 ScientificForm[t0/t0SI-1,NumberSigns->{"-","+"}]},
{"2T    [s]",ScientificForm[1/H0,16],ScientificForm[Mpc/HPC[QCB]/km,16],
 ScientificForm[HPC[QCB]/Mpc*km/H0-1,NumberSigns->{"-","+"}]},
{"2T    [a]",ScientificForm[1/H0/year,16],ScientificForm[Mpc/HPC[QCB]/km/year,16],
 ScientificForm[HPC[QCB]/Mpc*km/H0-1,NumberSigns->{"-","+"}]},
{"R∞",ScientificForm[R∞,16],ScientificForm[R∞SI,16],
 ScientificForm[R∞/R∞SI-1,NumberSigns->{"-","+"}]},
```

```
{"Om1",ScientificForm[Om1,16],"n.a.","unusual"},
{"Om0",ScientificForm[Om0,16],ScientificForm[c/r0SI,16],
 ScientificForm[Om0*2*t0SI-1,NumberSigns->{"-","+"}]},
{"OmR∞",ScientificForm[OmR∞,16],ScientificForm[OmR∞SI,16],
 ScientificForm[OmR∞/OmR∞SI-1,NumberSigns->{"-","+"}]},
{"cR∞",ScientificForm[cR∞,16],ScientificForm[cR∞SI,16],
 ScientificForm[cR∞/cR∞SI-1,NumberSigns->{"-","+"}]},
{"H0  [1/s]",ScientificForm[H0,16],ScientificForm[HPC[QCB]/Mpc*km,16],
 ScientificForm[H0/(HPC[QCB]/Mpc*km)-1,NumberSigns->{"-","+"}]},
{"km/s/Mpc]",NumberForm[HPC[Q0],16],ToString[ NumberForm[HPC[QCB],16]]<> " ©",
 ScientificForm[HPC[Q0]/HPC[QCB]-1,NumberSigns->{"-",
"+"}]},{"q1",ScientificForm[q1,16],"n.a.","unusual"},
{"q0",ScientificForm[q0,16],ScientificForm[q0SI,16],
 ScientificForm[q0/q0SI-1,NumberSigns->{"-",
"+"}]},{"qe",ScientificForm[qe,16],ScientificForm[qeSI,16],
 ScientificForm[qe/qeSI-1,NumberSigns->{"-",
"+"}]},{"U1",ScientificForm[U1,16],"n.a.","unusual"},
{"U0",ScientificForm[U0,16],ScientificForm[U0SI,16],
 ScientificForm[U0/U0SI-1,NumberSigns->{"-",
"+"}]},{"W1",ScientificForm[W1,16],"n.a.","unusual"},
{"W0",ScientificForm[W0,16],ScientificForm[W0SI,16],
 ScientificForm[W0/W0SI-1,NumberSigns->{"-",
"+"}]},{"S1",ScientificForm[S1,16],"n.a.","unusual"},
{"S0",ScientificForm[S0,16],"n.a.","unusual"},
{"σe",ScientificForm[σe,16],ScientificForm[σeSI,16],
 ScientificForm[σe/σeSI-1,NumberSigns->{"-","+"}]},
{"ae",ScientificForm[ae,16],ScientificForm[aeSI,16],
 ScientificForm[ae/aeSI-1,NumberSigns->{"-","+"}]},
{"ge",ScientificForm[ge,16],ScientificForm[geSI,16],
 ScientificForm[ge/geSI-1,NumberSigns->{"-","+"}]},
{"γe",ScientificForm[γe,16],ScientificForm[γeSI,16],
 ScientificForm[γe/γeSI-1,NumberSigns->{"-","+"}]},
{"μe",ScientificForm[μe,16],ScientificForm[μeSI,16],
 ScientificForm[μe/μeSI-1,NumberSigns->{"-",
"+"}]},{"μB",ScientificForm[μB,16],ScientificForm[μBSI,16],
 ScientificForm[μB/μBSI-1,NumberSigns->{"-","+"}]},
{"μN",ScientificForm[μN,16],ScientificForm[μNSI,16],
 ScientificForm[μN/μNSI-1,NumberSigns->{"-","+"}]},
{"Φ0",ScientificForm[Φ0,16],ScientificForm[Φ0SI,16],
 ScientificForm[Φ0/Φ0SI-1,NumberSigns->{"-","+"}]},
{"GQ0",ScientificForm[GQ0,16],ScientificForm[GQ0SI,16],
 ScientificForm[GQ0/GQ0SI-1,NumberSigns->{"-","+"}]},
{"KJ",ScientificForm[KJ,16],ScientificForm[KJSI,16],
 ScientificForm[KJ/KJSI-1,NumberSigns->{"-","+"}]},
{"RK",ScientificForm[RK,16],ScientificForm[RKSI,16],
 ScientificForm[RK/RKSI-1,NumberSigns->{"-","+"}]},
{"α",ScientificForm[alpha,16],ScientificForm[alphaSI,16],
 ScientificForm[alpha/alphaSI-1,NumberSigns->{"-",
"+"}]},{"δ",ScientificForm[delta,16],ScientificForm[deltaSI,16],
 ScientificForm[delta/deltaSI-1,NumberSigns->{"-",
"+"}]},{"x~",ScientificForm[xtilde,16],ScientificForm[2.821439372`,16],
"exactly"},{"σ",ScientificForm[σ,16],ScientificForm[σSI,16], "exactly"}};

Grid[Prepend[data,{"Value\r","Calculated","SI\rCOBE ©","Δy\r"}],
Background->{None,{Lighter[Blend[{Blue,Green}],.8]}},Frame->All,Alignment->{Left}]
```

Figure 9

```
N06=SetPrecision[Rk[2/3]/Rn[2/3],20];

Plot[RS[10^y], {y, -3, 3}];
Show[{%,
  GV[Log10[0.656729], 0.996, 1.038],
  GV[Log10[1.90812], 1.032, 1.036],
  GH[N06, Log10[.9*0.656729], 0.6],
  GH[1.0354, Log10[.9*1.90812], 0.9]},
ImageSize -> Full, PlotLabel -> None,
LabelStyle -> {FontFamily -> "Chicago", 12, GrayLevel[0]}]
```

Figure 11

```
Plot[QQ[10^t9],{t9,-8,8}];
Show[%,GV[-0.182570,-0.05,1.0365],
  GH[1,-8,8],GH[0,-8,8],
  GH[0.494482,-8,8],GH[0.302904,-8,8],
PlotRange->{0,1.0365},ImageSize->Full,PlotLabel->None,
LabelStyle->{FontFamily->"Chicago",12,GrayLevel[0]},AxesOrigin->{0,0}]
```

Figure 12

```
Plot[{alphaF[10^t10]}, {t10, -8, 8}] (* AlphaF *);
Show[%, GV[-0.18257004098843227, -0.008, 0.09],
  GH[0.07957741926604499, -8, 8],
  GH[0.007297363635890055, -8, 8],
  GH[0.016905867990336505, -8, 8], ImageSize -> Full,
PlotLabel -> None,
LabelStyle -> {FontFamily -> "Chicago", 12, GrayLevel[0]}]
```

Figure 13

Composed of two parts (alpha^{-1} and delta)

```
Plot[{deltaF[(10^(t10)/t1)^.5]}, {t10, (Log10[t1] - 16), (Log10[t1] + 16)},
  ImageSize -> Full, PlotLabel -> None,
  LabelStyle -> {FontFamily -> "Chicago", 12, GrayLevel[0]},
  AxesOrigin -> {(Log10[t1] - 16), 1}]
Plot[{1/alphaF[10^t10]}, {t10, -8, 8},
  ImageSize -> Full, PlotLabel -> None,
  LabelStyle -> {FontFamily -> "Chicago", 12, GrayLevel[0]},
  AxesOrigin -> {8, 0}];
Show[%, GV[-0.18257004098843227, -8, 145], GV[0, -8, 145],
  GH[12.56637887007592, -8, 8],
  GH[137.0357912660098, -8, 8],
  GH[59.15105929915021, -8, 8]]
```

Figure 14

```
Plot[{
  Log10[M2](*M2*),
  Log10[hb1/c/r1/(10^t10)](*M1*),
  Log10[hb1/c/r1/(10^t10)^2(*m0*)],
  Log10[1/(9Pi^2Sqrt[2]*delta/M2* (10^t10)^(7/3))](*me*),
  Log10[hb1/c/r1/(10^t10)^3(*mH*)]
},{t10,Log10[Q0]-70,Log10[Q0]+2}];
Show[{%,
  GV[N[-12/2],-52,152],
  GV[N[-2/3],-52,152],
  GV[0,-52,152],
  GV[Log10[Q0],-52,152],
  GH[Log10[M1],Log10[Q0]-70,Log10[Q0]+2],
  GH[Log10[m0],Log10[Q0]-70,Log10[Q0]+2],
  GH[Log10[me],Log10[Q0]-70,Log10[Q0]+2]},
ImageSize->Full,PlotLabel->None, PlotRange->{-42,142},
LabelStyle->{FontFamily->"Chicago",12,GrayLevel[0]}]
```

Figure 15

```
Plot[{
  Log10[M2](*M2*),
  Log10[hb1/c/r1/(10^t10)](*M1*),
  Log10[hb1/c/r1/(10^t10)^2(*m0*)],
  Log10[1/(9 Pi^2 Sqrt[2]*deltaF[10^t10]/M2*(10^t10)^(7/3))](*me(Q)*),
  Log10[1/(9 Pi^2 Sqrt[2]*delta/M2*(10^t10)^(7/3))](*me*),
  Log10[hb1/c/r1/(10^t10)^3(*mH*)]
}, {t10, Log10[Q0] - 63.3, Log10[Q0] - 57.3}];
Show[{%, GV[-0.86836, -50, 150],
  GV[-1.55339, -50, 150], GV[0, -50, 150],
```

```
  GV[-6.21358, -50, 150], GV[Log10[2/3], -50, 150],
  GH[Log10[1.118124*10^115], Log10[Q0] - 63.3, Log10[Q0] - 57.3]},
ImageSize -> Full, PlotLabel -> None,
LabelStyle -> {FontFamily -> "Chicago", 12, GrayLevel[0]}]
```

Figure 16

```
u1 = UeV[vQ0[1]]
u2 = UeV[vQ0[10^3]]
u3 = UeV[vQ0[QQrelU[M1 c^2/qe]]]
u4 = U1
QQrelU[U1] " Q(U1)"
QQrelU[U0] " Q(U0)"
M1*c^2 "Maximum M1c2"
U0*qe "U0*qe energy"
U1*qe "U1*qe energy"
M1 c^2/U1/qe "Enough for 11 electrons only"
l1 = Log10[u1]  (*Q=1*);
l2 = Log10[u2]  (*Q=103*);
l3 = Log10[u3]  (*Maximum M1c2=2.44470*10^5*);
l4 = Log10[u4]  (*Maximum voltage U1*);

Plot[QQrelU[10^t9], {t9, 87, 110}];
Show[{%,
  GV[l1, -50, 2000],
  GV[l2, -50, 2000],
  GV[l3, -50, 2000],
  GV[l4, -50, 2000]},
ImageSize -> Full, PlotRange -> {0, 1001}, PlotLabel -> None,
LabelStyle -> {FontFamily -> "Chicago", 12, GrayLevel[0]}]
```

Figure 17

```
FindMaximum[QQ[QQrelU[10^t11]], {t11, 87, 110}]

Plot[{QQ[QQrelU[10^t11]]}, {t11, 87, 110}];
Show[{%,
  GV[l1, -0.08, 1.08], GV[l2, -0.08, 1.08],
  GV[l3, -0.08, 1.08], GV[l4, -0.08, 1.08],
  GH[1, 87, 110], GH[0.460918, 87, 110],
  GH[0.302904, 87, 110], GH[0, 87, 110]},
PlotRange -> {0, 1.0365}, ImageSize -> Full, PlotLabel -> None,
LabelStyle -> {FontFamily -> "Chicago", 12, GrayLevel[0]}]
```

Figure 18

```
Plot[{1/4/Pi*(QQ[QQrelU[10^t10]])^2},{t10,87,110}] (* Alpha *);
Show[{%,
  GV[l1,-0.04,0.085],GV[l2,-0.04,0.085],
  GV[l3,-0.04,0.085],GV[l4,-0.04,0.085],
  GH[0.07957741926604,87,110],GH[0.007297363635890,87,110],
  GH[0.016905867990336,87,110]},
ImageSize->Full,PlotLabel->None,
LabelStyle->{FontFamily->"Chicago",12,GrayLevel[0]}]
```

Figure 20c

```
cc = 7.519884824;     (*Sqrt[π]] exact ξ*)
Plot[{10 Log10[s2[10^y]],
  10 (Log10[s1[10^y]] + Log10[E]*Psi2[10^y]) + 10 Log10[gdc[10^y]],
  Xline[y, Log10[2]]}, {y, -3, 3}, PlotRange -> {-51, 4.5},
 ImageSize -> Full,
 LabelStyle -> {FontFamily -> "Chicago", 10, GrayLevel[0]}]
```