# Quantum Gravity Waves – Part 4: More of Newton's Gravity

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## Abstract

One of the standard text-book derivations of Newton's gravity from Einstein's General Theory of Relativity uses the Einstein-linearization of his field equations. It is the same linearization which also results in solutions of gravitational waves, but it requires a few more approximations in order to come to Newton.

In a recent series of papers [A1, A2, A3] we have demonstrated that the classical approaches for the simplest linearization of the Einstein Field Equations under the assumption of weak gravitational fields and small velocities [A4], not only allows us to obtain wave-like field equations in vacuum for the original Einstein equations, but also the corresponding quantum gravity field equations. These quantum field equations already contain matter or matter-like terms without the need of adding them artificially (as Hilbert and Einstein did) via a matter Lagrange density (Hilbert) or directly (Einstein) via an energy-momentum tensor. We demonstrate how our "matter" from the quantum field equations connects with Newton's mass density in the classical gravity theory from Newton [A1].

In here we will derive the Newton gravity potential in an even simpler way by directly starting from the Quantum Gravity field equations. Of course this raises the question again [A5], whether the Newton theory already contains or even is based more on the quantum aspect of Einstein's General Theory of Relativity than its classical part [A6].

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## Introduction

Gravity waves are an outcome of Einstein's great general theory of relativity and they are a standard topic in the corresponding textbook literature (e.g. [1], pp 325). Usually, the derivations are restricted to the linearized Einstein Field Equations and – if even mentioned – the problem of quantization, respectively quantized wave solutions is not discussed. In the context – just as also done in [1] – often also the extraction of Newton's gravity theory from the General Theory of Relativity is been treated,

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whereby the reader gets the impression that the many approximations, assumptions and "transformation-tricks", which are necessary to finally end up with Newton, indicate more strangeness between the two theories than one would expect when assuming that the first follows from the second.

In this paper, we will present a simple extension of the classical linear gravity waves, showing how this might lead to a Quantum Gravity approach. We will demonstrate that it requires only a small adaptation of the classical Hilbert and Einstein achievements [2, 3] to come up with such a Quantum Gravity Theory or – as it is sometimes also been called - a "Theory of Everything".

In a variety of previous publications [4 – 16], this author has shown how a simple scaling factor to the metric tensor already leads to a quantum gravity field equational outcome. The "problem" with this finding of course is, that Hilbert should get all the credit for already having found a - or THE - "Theory of Everything" over 100 years ago. There wasn't much to be done, unless one counts adding a scaling factor as "much", which this author definitively does not. He sees such a "work" as a mere finding in another's paper, namely, Hilbert's "Die Grundlagen der Physik" from 1915 [1]. However, with tens of thousands of jobs at stake because they all depend on the fact that – apparently - there is no Theory of Everything yet, people obviously have problems or – to use a psychological term in order to give - at least - some of these scientists an excuse for their blindness – face an undeniable cognitive dissonant barrier to recognize that Hilbert has already done almost all the work. Worse still, it was also shown [17] that – in principle – variational kernels in the Einstein-Hilbert action of the type f[R], as they are necessary to produce the endless output of new field equations some of the more creative and paper-productive researcher are permanently proposing, and as they are also necessary for so many other Trans-Planckian approaches, are not of need, because those could always be substituted by a suitable metric scaling factor [17] without changing the total variational (Hilbert!!!) integral, which – after all – is a scalar. With the potential wall of recognition too high to be overcome by most of the string, loop gravity, trans Planckians and whatever else researchers, perhaps the quantum mechanical tunneling will help them to just – one day – miraculously diffuse through this barrier. Until then, the circus will probably produce tens of thousands more of completely useless "scientific" "contributions", while the simple fact that the job was already done over 100 years ago continues to be hushed up.

De facto, one may even say that this author also just "produces papers". Even worse, he always repeats the same things. This, however, is more for convenience in order to give the essentials before adding the new aspect, the author intends to consider. We see no need to hide the redundancy. Those who are already familiar with the basics, can easily skip the introduction and first theory sections.

In this paper, we will apply the rather straight forward and very rich Hilbert approach… just a tiny bit expanded, respectively, generalized and then try to extract Newton's gravity from there. Thereby it should be noted that due to the inconsistencies resulting from the classical approximation process, we have a variety of options. It should also be pointed out that – in principle – we already have a very simple transition from the Quantum Gravity field equations to Newton's gravity (thereby finding Newton's gravity as a pure quantum or fuzziness effect) [16], being based on the fact that any perturbational factor in the Hilbert variational kernel could be absorbed by the metric as a volume scaling [17].

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# A Quantum Gravity Theory

We start with the following scaled metric tensor and force it into the Einstein-Hilbert action variational problem [2] as follows:

$$G_{\alpha\beta} = g_{\alpha\beta} \cdot F[f] \quad \rightarrow \quad \delta W = 0 = \delta \int_V d^n x \sqrt{-G} \cdot \left( R^* - 2 \cdot \Lambda \right) \tag{1}$$

Here Λ is the cosmological constant, G denotes the determinant of the metric tensor from (1) and $R^*$ gives the corresponding Ricci scalar. Performing the variation with respect to the metric $G_{\alpha\beta}$ results in:

$$0 = \left( \begin{array}{c} \boxed{\boxed{R_{\alpha\beta} - R\frac{g_{\alpha\beta}}{2} + \Lambda \cdot g_{\alpha\beta}}} \\ -\frac{1}{2F}\left( \begin{array}{c} F_{,\alpha\beta}(n-2) + F_{,ab} g_{\alpha\beta} g^{ab} + F_{,a} g^{ab} \left( g_{\beta b,\alpha} - g_{\beta\alpha,b} \right) - \\ F_{,\alpha} g^{ab} g_{\beta b,a} - F_{,\beta} g^{ab} g_{\alpha b,a} + F_{,d} g^{cd} \left( \begin{array}{c} g_{\alpha c,\beta} - \frac{1}{2} n g_{\alpha c,\beta} - \frac{1}{2} n g_{\beta c,\alpha} \\ + \frac{1}{2} n g_{\alpha\beta,c} + \frac{1}{2} g_{\alpha\beta} g_{ab,c} g^{ab} \end{array} \right) \end{array} \right) \\ + \frac{1}{4F^2}\left( F_{,\alpha} \cdot F_{,\beta} (3n-6) + g_{\alpha\beta} F_{,c} F_{,d} g^{cd} (4-n) \right) \\ + (n-1)\left( \frac{1}{2F}\left( \begin{array}{c} 2\Delta F - 2F_{,d} g^{cd}{}_{,c} \\ -\frac{n}{(n-1)} F_{,d} g^{cd} g^{ab} g_{ac,b} \end{array} \right) + \frac{g^{ab} F_{,a} \cdot F_{,b}}{4F^2}(n-6) \right) \cdot \frac{g_{\alpha\beta}}{2} \end{array} \right) \delta G^{\alpha\beta} \tag{2}$$

and shows us that we have not only obtained the classical Einstein Theory of General Relativity [3] (see boxed terms exactly giving the Einstein Field Equations in vacuum plus the cosmological constant term), but also a set of quantum field equations for the scaling function F, clearly playing the role of the wave-function. It was shown in our previous publications [4, 5, 6, 7, 8] that these additional terms are quantum equations, fully covering the main aspects of relativistic classical quantum theory. Everything else can be obtained by a few generalizations, structural shaping and the introduction of the variation with respect to the degrees of freedom or number of dimensions [4, 5, 6, 7, 8]. So, we conclude, that we indeed have a Quantum Gravity Theory or Theory of Everything, as one also calls it, at hand, whereby it should be pointed out that (2) has to be considered the simplest possible – and still general (see [4, 5, 6, 7, 8]) - form for the corresponding quantum gravity field equations.

## "Weak Gravity" and Linearity – The Transition to the Classical Quantum Theory

It was shown in [5, 6, 7, 8] that the so-called "weak gravity" condition:

$$\delta G^{\alpha\beta} = G^{\alpha\beta} \cdot \delta_0 + \overbrace{G^{ab} \delta^{\alpha\beta}_{ab}}^{\text{Gravity}} \xrightarrow{\forall\, \delta^{\alpha\beta}_{ab} \ll \delta_0} = \frac{g^{\alpha\beta}}{F} \cdot \delta_0 \,, \tag{3}$$

together with a setting for the scaling function F[f] as follows:

$$F[f] = \begin{cases} C_F \cdot (f + C_f)^{\frac{4}{n-2}} & n \neq 2 \\ C_F \cdot e^{f \cdot C_f} & n = 2 \end{cases}. \tag{4}$$

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leads to a significant simplification and scalarization of the quantum gravity field equations (2), namely:

$$0 = \mathrm{R} - \frac{\mathrm{F}'}{2\mathrm{F}}\left((\mathrm{n}-1)\left(2\mathrm{g}^{\mathrm{ab}}\mathrm{f}_{,\mathrm{ab}} + \mathrm{f}_{,\mathrm{d}}\mathrm{g}^{\mathrm{cd}}\mathrm{g}^{\mathrm{ab}}\mathrm{g}_{\mathrm{ab,c}}\right) - \mathrm{n}\mathrm{f}_{,\mathrm{d}}\mathrm{g}^{\mathrm{cd}}\mathrm{g}^{\mathrm{ab}}\mathrm{g}_{\mathrm{ac,b}}\right). \tag{5}$$

This equation is completely linear in f, which not only has the characteristics of a quantum function, but – for a change – gives us the opportunity to metrically see what QUANTUM actually means, namely, a volume jitter to the metric of the system in question… at least this is one quantum option, because we have already seen others, like the perturbated kernel (e.g. see [8]).

Interestingly, for metrics without shear elements:

$$\mathrm{g}_{\mathrm{ij}} = \begin{pmatrix} \mathrm{g}_{00} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \mathrm{g}_{\mathrm{n-1n-1}} \end{pmatrix}; \quad \mathrm{g}_{\mathrm{ii,i}} = 0\,, \tag{6}$$

and applying the solution for F[f] from (4) the derivative terms in (5), which is to say:

$$(\mathrm{n}-1)\left(2\mathrm{g}^{\mathrm{ab}}\mathrm{f}_{,\mathrm{ab}} + \mathrm{f}_{,\mathrm{d}}\mathrm{g}^{\mathrm{cd}}\mathrm{g}^{\mathrm{ab}}\mathrm{g}_{\mathrm{ab,c}}\right) - \mathrm{n}\mathrm{f}_{,\mathrm{d}}\mathrm{g}^{\mathrm{cd}}\mathrm{g}^{\mathrm{ab}}\mathrm{g}_{\mathrm{ac,b}}\,. \tag{7}$$

converge to the ordinary Laplace operator, namely:

$$\mathrm{R}^{*} = 0 \quad \rightarrow \quad 0 = \mathrm{F}\cdot\mathrm{R} + \mathrm{F}'\cdot(1-\mathrm{n})\cdot\Delta\mathrm{f}$$

$$\Rightarrow \quad 0 = \begin{cases} \left(\mathrm{f} - C_{\mathrm{f}}\right)^{\frac{4}{n-2}} \cdot C_{\mathrm{F}}\left(\mathrm{R} + \dfrac{4}{\mathrm{n}-2}\cdot\dfrac{(1-\mathrm{n})}{(\mathrm{f}-C_{\mathrm{f}})}\cdot\Delta\mathrm{f}\right) & \mathrm{n} > 2\,\cdot \\ \mathrm{e}^{C_{\mathrm{f}}\cdot\mathrm{f}}\cdot C_{\mathrm{F}}\left(\mathrm{R} + C_{\mathrm{f}}\cdot(1-\mathrm{n})\cdot\Delta\mathrm{f}\right) & \mathrm{n} = 2 \end{cases} \tag{8}$$

We recognize the relativistic Klein-Gordon equation.

Thus, in the case of n>2 we always also have the option for a constant (broken symmetry) solution of the kind:

$$0 = \mathrm{f} - C_{\mathrm{f}0} \quad \Rightarrow \quad \mathrm{f} = C_{\mathrm{f}0}\,. \tag{9}$$

In all other cases, meaning where $\mathrm{f} \neq C_{\mathrm{f}0}$, we have the simple equations:

$$0 = \begin{cases} \left(\mathrm{f} - C_{\mathrm{f}0}\right)\cdot\mathrm{R} + (1-\mathrm{n})\cdot\dfrac{4}{\mathrm{n}-2}\cdot\Delta\mathrm{f} & \mathrm{n} > 2 \\ \mathrm{R} + C_{\mathrm{f}0}\cdot(1-\mathrm{n})\cdot\Delta\mathrm{f} & \mathrm{n} = 2 \end{cases}. \tag{10}$$

A critical argument should now be that this equation is not truly of Klein-Gordon character as it does contain neither potential nor mass, but this author has already shown that this problem is easily solved by adding additional dimensions carrying the right properties to produce masses and potentials due to entanglement, being provided by the right scaling function F[f] (e.g. [4 – 8]).

Using these results we were able to develop a quantum gravity statistics [9, 10], formulate a Heisenberg uncertainty principle containing gravity [12] and even suggesting a path for answering the riddle of the 3 generations of elementary particles [13].

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## Finding Matter

Observing our variational result (2) and comparing with the classical equations from [3]:

$$R_{\alpha\beta} - \frac{1}{2} R \cdot g_{\alpha\beta} + \Lambda \cdot g_{\alpha\beta} = -\kappa \cdot T_{\alpha\beta}, \tag{11}$$

where we have: $R_{\alpha\beta}$, $T_{\alpha\beta}$ the Ricci- and the energy momentum tensor, respectively, while the parameters $\Lambda$ and $\kappa$ are constants (usually called cosmological and coupling constant, respectively), we realize that the following terms of (2) are just the most natural energy momentum tensor elements, yielding the following identity:

$$\kappa \cdot T_{\alpha\beta} = \left( \begin{array}{c} -\frac{1}{2F} \left( \begin{array}{c} F_{,\alpha\beta}(n-2) + F_{,ab} g_{\alpha\beta} g^{ab} + F_{,a} g^{ab} \left( g_{\beta b,\alpha} - g_{\beta\alpha,b} \right) - \\ F_{,\alpha} g^{ab} g_{\beta b,a} - F_{,\beta} g^{ab} g_{\alpha b,a} + F_{,d} g^{cd} \left( \begin{array}{c} g_{\alpha c,\beta} - \frac{1}{2} n g_{\alpha c,\beta} - \frac{1}{2} n g_{\beta c,\alpha} \\ + \frac{1}{2} n g_{\alpha\beta,c} + \frac{1}{2} g_{\alpha\beta} g_{ab,c} g^{ab} \end{array} \right) \end{array} \right) \\ + \frac{1}{4F^2} \left( F_{,\alpha} \cdot F_{,\beta} (3n-6) + g_{\alpha\beta} F_{,c} F_{,d} g^{cd} (4-n) \right) \\ + (n-1) \left( \frac{1}{2F} \left( \begin{array}{c} 2\Delta F - 2 F_{,d} g^{cd}{}_{,c} \\ - \frac{n}{(n-1)} F_{,d} g^{cd} g^{ab} g_{ac,b} \end{array} \right) + \frac{g^{ab} F_{,a} \cdot F_{,b}}{4F^2} (n-6) \right) \cdot \frac{g_{\alpha\beta}}{2} \end{array} \right). \tag{12}$$

# Simple Extraction of Newton's Gravity

When applying Einstein's linearization the derivation of Newton's gravity potential is pretty complicated and requires quite some approximations of the Einstein field equations [1]. In [14] section "Einstein's Linearization and Newton's Gravity Potential", we have shown how this leads to a "Quantum Newton Gravity" when following this path and incorporating the metric scaling from (1). In here we now demonstrate how Newton's gravity potential can be derived much easier and more directly from the quantum "Führungsfeld" of the metric tensor.

Our starting point is the "weak gravity" result from our field equations, where we take from (5) and the condition (6), that the resulting equation:

$$\begin{aligned} R^* = 0 \quad &\rightarrow \quad 0 = F \cdot R + F' \cdot (1-n) \cdot \Delta f \\ \Rightarrow \quad 0 = &\begin{cases} (f - C_f)^{\frac{4}{n-2}} \cdot C_F \left( R + \frac{4}{n-2} \cdot \frac{(1-n)}{(f-C_f)} \cdot \Delta f \right) & n > 2, \\ e^{C_f \cdot f} \cdot C_F \left( R + C_f \cdot (1-n) \cdot \Delta f \right) & n = 2 \end{cases} \end{aligned} \tag{13}$$

already gives us all what is of need to derive Newton's potential.

At first we remember that the Newton potential is considered time-independent, which makes (13):

$$R + \frac{4}{n-2} \cdot \frac{(1-n)}{(f-C_f)} \cdot \Delta f \xrightarrow{\partial_t f = \partial_0 f = 0} = R + \frac{4}{n-2} \cdot \frac{(1-n)}{(f-C_f)} \cdot \Delta_{1\ldots n-1} f = 0, \tag{14}$$

thereby we ignored the case n=2. Then we separate all dimensions not having to do with our ordinary three (Newtonian space), leading us to:

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$$\mathrm{R}\cdot\frac{\mathrm{n}-2}{4\cdot(1-\mathrm{n})}\cdot(\mathrm{f}-C_{\mathrm{f}})+\Delta_{1,2,3}\mathrm{f}+\Delta_{4\ldots\mathrm{n}-1}\mathrm{f}=0\,. \tag{15}$$

Comparison with the Newtonian potential equation:

$$\Delta_{1,2,3}\varphi_{\mathrm{Newton}}=4\cdot\pi\cdot\mathrm{G}\cdot\rho \quad\equiv\quad 4\cdot\pi\cdot\mathrm{G}\cdot\Delta_{1,2,3}\mathrm{f}\,, \tag{16}$$

with G here giving the Newton constant (and not the determinant of the scaled metric tensor as the letter was used for above) and ρ denoting the mass density, yields:

$$\Delta_{1,2,3}\mathrm{f}=\frac{\Delta_{1,2,3}\varphi_{\mathrm{Newton}}}{4\cdot\pi\cdot\mathrm{G}}=-\left(\mathrm{R}\cdot\frac{\mathrm{n}-2}{4\cdot(1-\mathrm{n})}\cdot(\mathrm{f}-C_{\mathrm{f}})+\Delta_{4\ldots\mathrm{n}-1}\mathrm{f}\right)\cdot \tag{17}$$

Incorportation of the Ricci scalar with:

$$\mathrm{R}=\mathrm{R}_{\alpha\beta}\mathrm{g}^{\alpha\beta}=\mathrm{g}^{\alpha\beta}\begin{pmatrix}-\frac{1}{2}\left(\mathrm{g}_{\alpha\beta,\mathrm{ab}}+\mathrm{g}_{\mathrm{ab},\alpha\beta}-\mathrm{g}_{\alpha\mathrm{b},\mathrm{a}\beta}-\mathrm{g}_{\beta\mathrm{b},\mathrm{a}\alpha}\right)\mathrm{g}^{\mathrm{ab}}\\+\frac{1}{2}\left(\frac{1}{2}\mathrm{g}_{\mathrm{ac},\alpha}\cdot\mathrm{g}_{\mathrm{bd},\beta}+\mathrm{g}_{\alpha\mathrm{c},\mathrm{a}}\cdot\mathrm{g}_{\beta\mathrm{d},\mathrm{b}}-\mathrm{g}_{\alpha\mathrm{c},\mathrm{a}}\cdot\mathrm{g}_{\beta\mathrm{b},\mathrm{d}}\right)\mathrm{g}^{\mathrm{ab}}\mathrm{g}^{\mathrm{cd}}\\-\frac{1}{2}\left(\mathrm{g}_{\alpha\mathrm{c},\beta}\mathrm{g}_{\mathrm{bd},\mathrm{a}}+\mathrm{g}_{\beta\mathrm{c},\alpha}\mathrm{g}_{\mathrm{bd},\mathrm{a}}-\mathrm{g}_{\alpha\beta,\mathrm{c}}\mathrm{g}_{\mathrm{bd},\mathrm{a}}\right)\mathrm{g}^{\mathrm{ab}}\mathrm{g}^{\mathrm{cd}}\\+\frac{1}{4}\left(\mathrm{g}_{\alpha\mathrm{c},\beta}\mathrm{g}_{\mathrm{ab},\mathrm{d}}+\mathrm{g}_{\beta\mathrm{c},\alpha}\mathrm{g}_{\mathrm{ab},\mathrm{d}}-\mathrm{g}_{\alpha\beta,\mathrm{c}}\mathrm{g}_{\mathrm{ab},\mathrm{d}}\right)\mathrm{g}^{\mathrm{ab}}\mathrm{g}^{\mathrm{cd}}\end{pmatrix}, \tag{18}$$

finally, gives us a deeper – metric - understanding about the nature of the Newton gravity potential via:

$$\frac{\Delta_{1,2,3}\varphi_{\mathrm{Newton}}}{4\cdot\pi\cdot\mathrm{G}}=-\left(\mathrm{g}^{\alpha\beta}\begin{pmatrix}-\frac{1}{2}\begin{pmatrix}\mathrm{g}_{\alpha\beta,\mathrm{ab}}+\mathrm{g}_{\mathrm{ab},\alpha\beta}\\-\mathrm{g}_{\alpha\mathrm{b},\mathrm{a}\beta}-\mathrm{g}_{\beta\mathrm{b},\mathrm{a}\alpha}\end{pmatrix}\mathrm{g}^{\mathrm{ab}}\\+\frac{1}{2}\begin{pmatrix}\frac{1}{2}\mathrm{g}_{\mathrm{ac},\alpha}\cdot\mathrm{g}_{\mathrm{bd},\beta}\\+\mathrm{g}_{\alpha\mathrm{c},\mathrm{a}}\cdot\mathrm{g}_{\beta\mathrm{d},\mathrm{b}}\\-\mathrm{g}_{\alpha\mathrm{c},\mathrm{a}}\cdot\mathrm{g}_{\beta\mathrm{b},\mathrm{d}}\end{pmatrix}\mathrm{g}^{\mathrm{ab}}\mathrm{g}^{\mathrm{cd}}\\-\frac{1}{2}\begin{pmatrix}\mathrm{g}_{\alpha\mathrm{c},\beta}\mathrm{g}_{\mathrm{bd},\mathrm{a}}\\+\mathrm{g}_{\beta\mathrm{c},\alpha}\mathrm{g}_{\mathrm{bd},\mathrm{a}}\\-\mathrm{g}_{\alpha\beta,\mathrm{c}}\mathrm{g}_{\mathrm{bd},\mathrm{a}}\end{pmatrix}\mathrm{g}^{\mathrm{ab}}\mathrm{g}^{\mathrm{cd}}\\+\frac{1}{4}\begin{pmatrix}\mathrm{g}_{\alpha\mathrm{c},\beta}\mathrm{g}_{\mathrm{ab},\mathrm{d}}\\+\mathrm{g}_{\beta\mathrm{c},\alpha}\mathrm{g}_{\mathrm{ab},\mathrm{d}}\\-\mathrm{g}_{\alpha\beta,\mathrm{c}}\mathrm{g}_{\mathrm{ab},\mathrm{d}}\end{pmatrix}\mathrm{g}^{\mathrm{ab}}\mathrm{g}^{\mathrm{cd}}\end{pmatrix}\cdot\frac{\mathrm{n}-2}{4\cdot(1-\mathrm{n})}\cdot(\mathrm{f}-C_{\mathrm{f}})+\Delta_{4\ldots\mathrm{n}-1}\mathrm{f}\right)\,. \tag{19}$$

We realize that Newton's mass density can have two sources:

a) The Ricci curvature R or

b) Other dimensions contributing to the mass density via $-\frac{\Delta_{3\ldots\mathrm{n}-1}\mathrm{f}}{4\cdot\pi\cdot\mathrm{G}}$.

It should be noted at this point that we could even expand this – more or less - classical Newton gravity potential by avoiding the simplification (6) and directly applying (5):

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$$0 = \mathrm{R} - \frac{2}{\mathrm{n}-2}\cdot\frac{1}{\left(\mathrm{f}-C_{\mathrm{f}}\right)}\cdot\left((\mathrm{n}-1)\left(\overbrace{2\mathrm{g}^{\mathrm{ab}}\mathrm{f}_{,\mathrm{ab}}+\mathrm{f}_{,\mathrm{d}}\mathrm{g}^{\mathrm{cd}}\mathrm{g}^{\mathrm{ab}}\mathrm{g}_{\mathrm{ab,c}}}^{=2\Delta\mathrm{f}-2\mathrm{f}_{,\mathrm{d}}\mathrm{g}^{\mathrm{cd}}{}_{,\mathrm{c}}}\right)-\mathrm{n}\mathrm{f}_{,\mathrm{d}}\mathrm{g}^{\mathrm{cd}}\mathrm{g}^{\mathrm{ab}}\mathrm{g}_{\mathrm{ac,b}}\right), \tag{20}$$

leading to a more general – even time-dependent - „Newton gravity potential“:

$$0 = \mathrm{R}\cdot\frac{\mathrm{n}-2}{4\cdot(1-\mathrm{n})}\cdot\left(\mathrm{f}-C_{\mathrm{f}}\right)+\Delta\mathrm{f}-2\mathrm{f}_{,\mathrm{d}}\mathrm{g}^{\mathrm{cd}}{}_{,\mathrm{c}}+\frac{\mathrm{n}}{2\cdot(1-\mathrm{n})}\cdot\mathrm{f}_{,\mathrm{d}}\mathrm{g}^{\mathrm{cd}}\mathrm{g}^{\mathrm{ab}}\mathrm{g}_{\mathrm{ac,b}}$$

$$\xrightarrow{\Delta\mathrm{f}=\Delta_{0\ldots3}\mathrm{f}+\Delta_{4\ldots\mathrm{n}-1}\mathrm{f}} \tag{21}$$

$$\rho = \Delta_{0,1,2,3}\mathrm{f} = \frac{\Delta_{0,1,2,3}\varphi_{\mathrm{Newton}}}{4\cdot\pi\cdot\mathrm{G}} = -\left(\begin{array}{c}\mathrm{R}\cdot\dfrac{\mathrm{n}-2}{4\cdot(1-\mathrm{n})}\cdot\left(\mathrm{f}-C_{\mathrm{f}}\right)\\ +\Delta_{4\ldots\mathrm{n}-1}\mathrm{f}-2\mathrm{f}_{,\mathrm{d}}\mathrm{g}^{\mathrm{cd}}{}_{,\mathrm{c}}+\dfrac{\mathrm{n}}{2\cdot(1-\mathrm{n})}\cdot\mathrm{f}_{,\mathrm{d}}\mathrm{g}^{\mathrm{cd}}\mathrm{g}^{\mathrm{ab}}\mathrm{g}_{\mathrm{ac,b}}\end{array}\right)$$

Incorporation of the Ricci scalar leads to the complete extended “Newton” gravity equation:

$$\rho = \Delta_{0,1,2,3}\mathrm{f} = \frac{\Delta_{0,1,2,3}\varphi_{\mathrm{Newton}}}{4\cdot\pi\cdot\mathrm{G}} = -\left(\begin{array}{l}\mathrm{g}^{\alpha\beta}\left(\begin{array}{l}-\dfrac{1}{2}\left(\begin{array}{l}\mathrm{g}_{\alpha\beta,\mathrm{ab}}+\mathrm{g}_{\mathrm{ab},\alpha\beta}\\ -\mathrm{g}_{\alpha\mathrm{b},\mathrm{a}\beta}-\mathrm{g}_{\beta\mathrm{b},\mathrm{a}\alpha}\end{array}\right)\mathrm{g}^{\mathrm{ab}}\\ +\dfrac{1}{2}\left(\begin{array}{l}\dfrac{1}{2}\mathrm{g}_{\mathrm{ac},\alpha}\cdot\mathrm{g}_{\mathrm{bd},\beta}\\ +\mathrm{g}_{\alpha\mathrm{c},\mathrm{a}}\cdot\mathrm{g}_{\beta\mathrm{d},\mathrm{b}}\\ -\mathrm{g}_{\alpha\mathrm{c},\mathrm{a}}\cdot\mathrm{g}_{\beta\mathrm{b},\mathrm{d}}\end{array}\right)\mathrm{g}^{\mathrm{ab}}\mathrm{g}^{\mathrm{cd}}\\ -\dfrac{1}{2}\left(\begin{array}{l}\mathrm{g}_{\alpha\mathrm{c},\beta}\mathrm{g}_{\mathrm{bd},\mathrm{a}}\\ +\mathrm{g}_{\beta\mathrm{c},\alpha}\mathrm{g}_{\mathrm{bd},\mathrm{a}}\\ -\mathrm{g}_{\alpha\beta,\mathrm{c}}\mathrm{g}_{\mathrm{bd},\mathrm{a}}\end{array}\right)\mathrm{g}^{\mathrm{ab}}\mathrm{g}^{\mathrm{cd}}\\ +\dfrac{1}{4}\left(\begin{array}{l}\mathrm{g}_{\alpha\mathrm{c},\beta}\mathrm{g}_{\mathrm{ab},\mathrm{d}}\\ +\mathrm{g}_{\beta\mathrm{c},\alpha}\mathrm{g}_{\mathrm{ab},\mathrm{d}}\\ -\mathrm{g}_{\alpha\beta,\mathrm{c}}\mathrm{g}_{\mathrm{ab},\mathrm{d}}\end{array}\right)\mathrm{g}^{\mathrm{ab}}\mathrm{g}^{\mathrm{cd}}\end{array}\right)\cdot\dfrac{\mathrm{n}-2}{4\cdot(1-\mathrm{n})}\cdot\left(\mathrm{f}-C_{\mathrm{f}}\right)\\ +\Delta_{4\ldots\mathrm{n}-1}\mathrm{f}-2\mathrm{f}_{,\mathrm{d}}\mathrm{g}^{\mathrm{cd}}{}_{,\mathrm{c}}+\dfrac{\mathrm{n}}{2\cdot(1-\mathrm{n})}\cdot\mathrm{f}_{,\mathrm{d}}\mathrm{g}^{\mathrm{cd}}\mathrm{g}^{\mathrm{ab}}\mathrm{g}_{\mathrm{ac,b}}\end{array}\right). \tag{22}$$

We realize that due to the part:

$$\rho = \Delta_{0,1,2,3}\mathrm{f} = \frac{\Delta_{0,1,2,3}\varphi_{\mathrm{Newton}}}{4\cdot\pi\cdot\mathrm{G}}. \tag{23}$$

in (22) we also now also have a metric understanding for Newton’s “mass density”.

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