

On The Zero Point Field

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Abstract: Via a look at the Ricci and Weyl curvature tensors I show that from a quantum perspective the Zero Point Field or ZPF is the origin of both inertia and gravity. I also point out that accelerated expansion of the cosmos and a observational slow down of C should have been expected.

The Equation

The stress-energy tensor on the right side of the equation holds all the information about the distribution of energy and mass in space-time, but Einstein tensor on the left, has only information about Ricci curvature which is only part of the picture. The field equation only tells us how the curvature at a point is affected by the matter and energy that are present at this point. It affects only Ricci curvature. Weyl curvature at a point is caused by matter and energy at other points.

$$R_{ijkl} = C_{ijkl} + E_{ijkl} + G_{ijkl}$$

is the Riemann curvature tensor in its full format. Thus,

$$E_{ijkl} = -\frac{1}{2}(g_{ik}S_{jl} + g_{jl}S_{ik} - g_{il}S_{jk} - g_{jk}S_{il}),$$

with

$$S_{ij}$$

is the traceless tensor

$$S_{ij} \equiv R_{ij} - \frac{1}{4}g_{ij}R,$$

and

$$G_{ijkl}$$

is defined by

$$G_{ijkl} \equiv -\frac{R}{12}(g_{ik}g_{jl} - g_{il}g_{jk})$$

and

$$R_{ij}$$

is defined by

$$R_{ij} \equiv R_{ijk}^k \text{ and } R \equiv g^{ij} R_{ij}$$

these all can be written as

$$R_{ijkl} = C_{ijkl} + \frac{1}{2}(g_{il}R_{jk} + g_{jk}R_{il} - g_{ik}R_{jl} - g_{jl}R_{ik}) - \frac{R}{6}(g_{il}g_{jk} - g_{ik}g_{jl})$$

We have

$$E_a = F_{ab} u^b, \quad H_a = F_{ab}^* u^b$$

for the vacuum when observer is moving with time-like 4-velocity. This observer would feel the electric and magnetic components of the vacuum as

$$E_{ac} = C_{abcd} u^b u^d, \quad H_{ac} = {}^*C_{abcd} u^b u^d$$

Since this field is not purely electric or purely magnetic we have

$$C_{ab}^{cd} = 2u_{[a}E_{b]}^{[c}u^{d]} + \delta_{[a}^{[c}E_{b]}^{d]} - \eta_{abef} u^e H^{f[c}u^{d]} - \eta^{cdef} u_e H_{f[a}u_{b]}$$

which equals

$$C^{abcd} = (\eta^{acef} \eta^{bdpq} - g^{acef} g^{bdpq}) u_e u_p E_{fq} \\ + (\eta^{acef} g^{bdpq} - g^{acef} \eta^{bdpq}) u_e u_p H_{fq}$$

with

$$Q_b^a = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & \lambda_1 & 0 & 0 \\ 0 & 0 & \lambda_2 & 0 \\ 0 & 0 & 0 & \lambda_3 \end{bmatrix}$$

where

$$\lambda_3 = -(\lambda_1 + \lambda_2)$$

which in our case

Q

will contain real and imaginary components since the vacuum field is mixed and in constant flux as defined by quantum theory. As such it would be known as a radiative space-time. Since the vacuum as such has energy and energy is equal to mass it follows that the vacuum itself at some level tells space-time how to curve. But the components of both fields also constitute a drag effect for any object in motion. That drag effect has to be the origin of inertia and as such is the origin point of gravity.

If we take the space-matter tensor for a non-null EM field we have

$$P_{abcd} = C_{abcd} - g_{ac}F_{bk}F_d^k - g_{bd}F_{ap}F_c^p + g_{ad}F_{bt}F_c^t + g_{bc}F_{ax}F_d^x \\ + (\sigma + \frac{1}{2}F_{ij}F^{ij})(g_{ac}g_{bd} - g_{ad}g_{bc})$$

from which we get

$$P_{bcd}^h = C_{bcd}^h - \delta_c^h F_{bk}F_d^k - g_{bd}F_p^h F_c^p + \delta_d^h F_{bt}F_c^t + g_{bc}F_x^h F_d^x \\ + (\sigma + \frac{1}{2}F_{ij}F^{ij})(\delta_c^h g_{bd} - \delta_d^h g_{bc})$$

Thus,

$$T_{ab} = F_{ac}F_b^c$$

with

$$F_{ac} = s_a t_c - t_a s_c$$

$$s_a s^a = s_a t^a = 0, \quad t_a t^a = 1$$

where

$$x^i \rightarrow x^i + \xi^i dt$$

leaves

$$P_{bcd}^h$$

invariant which in turn implies motion of the medium and

$$\sigma = 0.$$

The motion of the medium is the expansion of the vacuum over time and as such it's motion is entangled with the CMB. An accelerated expansion implies an increasing motion to the medium. The differences in the field that should be evident would be those differences in the CMB itself. In such regions the vacuum's EM field would be moving at a different rate governed by the total energy present and it's effect on the excitation modes of the ZPF.

For accelerated expansion to occur there must be an increase of the amplitudes of the modes creating an increase in vacuum pressure countering gravity of the overall cosmos. A simple experiment involving two different size glasses of water on a vibrating platform will show that the larger glass shows higher amplitude waves. This in a crude format shows that accelerated expansion should have been expected as it is natural outcome of enlargement of the cosmic quantum sea.

In relation to particle travel or photons these higher amplitude waves amount to a longer travel distance generated at a quantum level which without quantum recalibration of our rulers results in C seeming to slowdown over time. But in reality it is our measurement of the distance of travel that is off and C has remained constant.