Doppler boosting a doublet version of the Dirac equation from a free fall grid onto a stationary grid in a central field of gravity.

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Abstract

This paper is a sequel to "Doppler Boosting a de Broglie Electron from a Free Fall Grid Into a Stationary Field of Gravity" [1]. We Doppler boost a de Broglie particle from a free fall grid onto a stationary field of gravity. This results in an identification of the two Doppler boost options with an electron energy double-valueness similar to electron spin. It seems that, within the limitations of our approach to gravity, we found a bottom up version of a possible theory of Quantum Gravity, on that connects the de Broglie hypothesis to gravity. This paper finishes and adapts "Towards a 4-D Extension of the Quantum Helicity Rotator with a Hyperbolic Rotation Angle of Gravitational Nature" for the quantum gravity part. We try to boost the de Broglie particle's quantum wave equation from the free fall grid to the stationary grid. We find that this is impossible on the Klein-Gordon level, the Pauli level and the Dirac level. But when we double the Dirac level and thus realize a kind of a Yang-Mills doublet level, we can formulate a doublet version of the Weyl-Dirac equation that can be Doppler boosted from the free fall grid into the stationary grid in a central field of gravity. In the end we add a quantitative prediction for the gravitational Doppler shift of the matter wave or probability density of an electron positron pair. Our free fall grid to stationary grid approach is ad-hoc and does not present a fundamental theory, but is a pragmatic attempt to formulate quantum mechanics outside the Poincaré group environment and beyond Lorentz symmetry.

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Introduction

I. THE DOPPLER BOOST IN FREE SPACE

The advantages with clocks and the radial speed of light in a central field of gravity is that they can be treated regardless of the radial direction. But as soon as we introduce wavelengths, the radial direction will be relevant.

In Special Relativity, a Doppler boost relative to a photon emitting atom equals a Lorentz boost relative to this atom. Using hyperbolic functions, with the Lorentz boost factor $\gamma = cosh\psi$, we get the Doppler boost factors, with emitter and observer moving toward each other (blue-shift)

$$\frac{\nu_{obs}}{\nu_{emit}} = e^{\psi} = cosh\psi + sinh\psi = \gamma + \gamma\beta = \gamma(1+\beta) = \frac{1}{\sqrt{1-\beta^2}} \cdot \sqrt{(1+\beta)^2} = \sqrt{\frac{(1+\beta)}{(1-\beta)}} \quad (1)$$

and in a similar way, with moving away emitter relative to observer (redshift)

$$\frac{\nu_{obs}}{\nu_{emit}} = e^{-\psi} = \sqrt{\frac{(1-\beta)}{(1+\beta)}} \quad (2)$$

Doppler boosts apply to the combination of waves and emitters.

If an atomic clock A on a stationary grid emits a photon, then the perceived frequency by an observer on a passing by free fall elevator as part of the free fall grid will depend on whether the passing by observer is just moving towards or away from the emitter at A. In one case he will use the Doppler boost factor e^{ψ}, in the other case he must apply $e^{-\psi}$. Once we go to de Broglie particles to be launched from the Minkowskian free fall grid onto platform A, the fact that the same free fall grid launcher has two Doppler options will matter. In our opinion, these two options for de Broglie particles will turn out to be the reason for the appearance of intrinsic electron spin.

II. PRINCIPLES OF THE DE BROGLIE ELECTRON NEEDED IN THIS PAPER

Modern post-orbital or post-"Bohr-Sommerfeld" quantum mechanics began with de Broglie's hypothesis of the existence of matter waves connected to particles with inertial mass [2]. De Broglie started with the assumption that every quantum of energy U should be connected to a frequency ν according to $U = h\nu$. with h as Planck's constant [3],[4]. Because he assumed every quantum of energy to have an inertial mass m_o and an inertial energy $U_0 = m_0c^2$ in its $h\nu_0 = m_0c^2$. De Broglie didn't restrict himself to one particular particle but considered a material moving object in general [3]. This object could be a photon (an atom of light), an electron, an atom or any other quantum of inertial energy. If this particle moved, the inertial energy and the associated frequency increased as $h\nu_i = U_i = \gamma U_0 = \gamma m_0 c^2 = \gamma h\nu_0$ so $\nu_i = \gamma\nu_0$. But the same particle should, according to de Broglie, be connectable to an inner frequency which, for a moving particle, transformed time-like in the same manner as the atomic clocks with period τ_{atom} and frequency ν_{atom} do in Einstein's Special Theory of Relativity.

Einstein attributed a clock-like frequency to every atom. De Broglie generalized Einstein's view by postulating that every isolated particle with a rest-energy possessed a clock-like frequency. Thus, de Broglie gave every particle two, and not just one, frequencies, their inertial-energy frequency ν_i and their inner-clock frequency ν_c. These frequencies were identical in a rest-system but fundamentally diverged in a moving frame according to $\nu_i = \gamma\nu_0$ and $\nu_c = \frac{1}{\gamma}\nu_0$.

This constituted an apparent contradiction for de Broglie, but he could solve it by a theorem which he called "Harmony of the Phases". He assumed the inertial energy of the moving particle to behave as a wave-like phenomenon and postulated the phase of this wave-like phenomenon to be at all times equal to the phase of the inner clock-like phenomenon. Both inner-clock- and wave-phenomenon were associated to one and the same particle, for example an electron, a photon or an atom. The inertial wave associated with a moving particle not only had a frequency ν_i but also a wave-length λ_i analogous to the fact that any inertial energy U_i of a moving particle had a momentum p_i associated to it.

The relativistic expressions for the inertial phase of a moving particle allowed de Broglie to postulate a wave-length λ_i associated to the magnitude of the electrons inertial momentum $\mathbf{p}_i$

$$\mid \mathbf{p}_i \mid = \frac{h}{\lambda_i}. \tag{3}$$

This inertial momentum could be interpreted as generated by an inertial energy-flow $U_i\mathbf{v}_{group}$ with

$$\mathbf{p}_i = \frac{U_i}{c^2}\mathbf{v}_{group}. \tag{4}$$

III. DOPPLER BOOSTING THE DE BROGLIE ELECTRON FROM THE FREE FALL GRID TO THE STATIONARY GRID IN A FIELD OF GRAVITY

It's like a paradox, but the results regarding photon and clock exchange between a free fall grid observers and stationary grid observers in a field of gravity seem to fit the de Broglie hypothesis better than the Minkowskian version. For a big part this is due to the gravitational apparent velocity of light for SG observer.

If a wavelike photon is emitted by a particle clock on the SG grid, we had

$$\frac{\nu_{\phi,p}}{c_{\phi,p}} = \frac{\frac{1}{\gamma_\phi}\nu_0}{\frac{1}{\gamma_\phi^2}c_0} = \frac{\gamma_\phi \nu_0}{c_0} = \frac{\nu_{\phi,w}}{c_0} = \frac{1}{\frac{1}{\gamma_\phi}\lambda_0} = \gamma_\phi \frac{1}{\lambda_0} = \frac{1}{\lambda_{\phi_w}}. \tag{5}$$

with $c_{\phi,p} = \frac{1}{\gamma_\phi^2}c_0$; $\nu_{\phi,p} = \frac{1}{\gamma_\phi}\nu_0$; $\nu_{\phi_w} = \gamma_\phi \nu_0$; $\lambda_{\phi,w} = \frac{1}{\gamma_\phi}\lambda_0$. If we applied a Doppler boost relative to the emitter of the photon, the result with an apparent Compton mass of the photon and a Doppler velocity was

$$\frac{U_d}{c} = \frac{U_0}{c}e^{\pm\psi} = \gamma(\frac{U_0}{c} \pm p_d) \tag{6}$$

If we take a de Broglie electron at rest on the free fall grid and Doppler boost it onto the stationary grid we get

$$\frac{U_0}{c_0}e^{\psi} = \gamma_\phi \frac{U_0}{c_0} + \gamma_\phi \beta_\phi \frac{U_0}{c_0} = \gamma_\phi m_0 c_0 + \gamma_\phi m_0 v_\phi = m_\phi(c_0 + v_\phi) = \gamma_\phi p_0 + p_\phi = \frac{U_\phi}{c_0} + p_\phi \tag{7}$$

or we get

$$\frac{U_0}{c_0}e^{-\psi} = \gamma_\phi \frac{U_0}{c_0} - \gamma_\phi \beta_\phi \frac{U_0}{c_0} = \gamma_\phi m_0 c_0 - \gamma_\phi m_0 v_\phi = m_\phi(c_0 - v_\phi) = \gamma_\phi p_0 - p_\phi = \frac{U_\phi}{c_0} - p_\phi \tag{8}$$

The electron on the stationary grid would however still be stationary on that grid, so if the stationary observer would apply Minkowski physics, he would assume a zero momentum and perhaps only a changed electron rest energy relative to the rest energy in infinity due to the gravitational potential, if he would consider it. Concerning rest mass, we have used $m_\phi = \gamma_\phi m_0$ which results in the apparent rest mass on the stationary grid

$$m_\phi = \gamma_\phi m_0 = \left(1 - \frac{\Phi}{c^2}\right) m_0 = \left(1 + \frac{GM}{Rc^2}\right) m_0 > m_0 \tag{9}$$

Gravitational energy at infinity on the FFG has been conversed into rest mass equivalent energy on the SG by intermediary of the Lorentz boost from a locally passing by FFG elevator. From the perspective of the free fall elevator observer, it isn't gravitational binding energy but just Doppler boost momentum energy. But rest mass energy is only part of the story, because there is also a hidden momentum on the stationary grid relative to the Minkowskian free fall grid. We didn't just went from U_0 to U_ϕ, we went from U_0 to $U_\phi \pm cp_\phi$. For the observer on the SG both electrons seem similar, but they have a hidden Doppler momentum difference.

In terms of matter waves, we take the de Broglie electron rest frequency and Doppler boost it on the SG platform. This results in

$$\frac{h\nu_0}{c_0}e^{\psi} = \gamma_\phi \frac{h\nu_0}{c_0} + \gamma_\phi\beta_\phi \frac{h\nu_0}{c_0} = \frac{h\nu_{\phi_w}}{c_0} + \frac{v_\phi}{c_0}\frac{h\nu_{\phi_w}}{c_0} = \frac{h\nu_{\phi_w}}{c_0} + m_\phi v_\phi = \frac{h\nu_{\phi_w}}{c_0} + \frac{h}{\lambda_\phi} \tag{10}$$

with the use of $h\nu_{\phi_w} = m_\phi c_0^2$. And we also have the possible Doppler boost to the same stationary position on the SG as

$$\frac{h\nu_0}{c_0}e^{-\psi} = \gamma_\phi \frac{h\nu_0}{c_0} - \gamma_\phi\beta_\phi \frac{h\nu_0}{c_0} = \frac{h\nu_{\phi_w}}{c_0} - \frac{v_\phi}{c_0}\frac{h\nu_{\phi_w}}{c_0} = \frac{h\nu_{\phi_w}}{c_0} - m_\phi v_\phi = \frac{h\nu_{\phi_w}}{c_0} - \frac{h}{\lambda_\phi} \tag{11}$$

So the gravitational stationary frequency of the electron on the SG platform has two possible slightly distinctive levels, as seen from the passing by FFG observer, because this FFG passing by observer could have Doppler boosted this electron in two different ways on the SG platform, given by the Doppler boost factor $e^{\pm\psi}$ and resulting in the matter waves $\frac{h\nu_{\phi_w}}{c_0} \pm \frac{h}{\lambda_\phi}$. But for the observer on the platform, this matter wave is a hidden one in terms of velocity of momentum vector quantities. This hidden matter wave is a true scalar matter wave.

IV. FROM DOPPLER BOOSTING TO LORENTZ BOOSTING THE DE BROGLIE ELECTRON FROM THE FFG TO THE SG

We would like to have one single operator description for the two valueness Doppler boosted electron $U_0 \to U_0 e^{\pm\psi} = U_\phi \pm cp_\phi$. We can do thus using the math-phys developed in a previous paper [5]. We will use the terminology developed in that paper without extensive introduction, assuming that the interested reader will invest time to study that paper. The first thing we do is multiply everything by the complex number $\mathbf{i}$. We start with the Doppler boost of the de Broglie electron $\frac{U_0}{c_0} \to \frac{U_0}{c_0}e^{\pm\psi} = \frac{U_\psi}{c_0} \pm p_\psi$ and multiply it by $\mathbf{i}$ to get

$$\mathbf{i}\frac{U_0}{c_0} \to \mathbf{i}\frac{U_0}{c_0}e^{\pm\psi} = \mathbf{i}\frac{U_\psi}{c_0} \pm \mathbf{i}p_\psi \tag{12}$$

Now we introduce the notations $E = \mathbf{i}\frac{U_0}{c_0}$, $p_0 = \mathbf{i}\frac{U}{c}$ and $p_1 = p_x$ and their boosted versions as $p_{0\psi} = \mathbf{i}\frac{U_\psi}{c_0}$ and $p_{1\psi} = p_{x\psi}$, which leads to the notation

$$E \to Ee^{\pm\psi} = \gamma E \pm \gamma\beta E = p_{0\psi} \pm \mathbf{i}p_{1\psi} \tag{13}$$

Then we introduce the notations $P_{00} = p_0 + \mathbf{i}p_1$ and $P_{11} = p_0 - \mathbf{i}p_1$ and introduce the biquaternion notation of paper [5] where $P = P^{\mu}\hat{\mathrm{K}}_{\mu}$ is written as

$$P = p_0\hat{1} + p_1\hat{\mathrm{I}} + p_2\hat{\mathrm{J}} + p_3\hat{\mathrm{K}} = p_0\hat{1} + \mathbf{p}\cdot\hat{\mathbf{K}}$$
$$= \begin{bmatrix} p_0 + \mathbf{i}p_1 & p_2 + \mathbf{i}p_3 \\ -p_2 + \mathbf{i}p_3 & p_0 - \mathbf{i}p_1 \end{bmatrix} = \begin{bmatrix} P_{00} & P_{01} \\ P_{10} & P_{11} \end{bmatrix}. \tag{14}$$

We then start with

$$P_{\psi} = \begin{bmatrix} Ee^{-\psi} & 0 \\ 0 & Ee^{+\psi} \end{bmatrix} = \begin{bmatrix} p_{0\psi} - \mathbf{i}p_{1\psi} & 0 \\ 0 & p_{0\psi} + \mathbf{i}p_{1\psi} \end{bmatrix} =$$
$$p_{0\psi}\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} - p_{1\psi}\begin{bmatrix} \mathbf{i} & 0 \\ 0 & -\mathbf{i} \end{bmatrix} = p_{0\psi}\hat{1} - p_{1\psi}\hat{\mathrm{I}} \tag{15}$$

and we can write $P_{\psi} = (E\hat{1})^{L} = U^{-1}(E\hat{1})U^{-1}$ with the Lorentz boost operator U as

$$U = \begin{bmatrix} e^{\psi/2} & 0 \\ 0 & e^{-\psi/2} \end{bmatrix} \tag{16}$$

With this notation we get

$$P_{-\psi} = (E\hat{1})^{-L} = U(E\hat{1})U = \begin{bmatrix} p_{0\psi} + \mathbf{i}p_{1\psi} & 0 \\ 0 & p_{0\psi} - \mathbf{i}p_{1\psi} \end{bmatrix} = p_{0\psi}\hat{1} + p_{1\psi}\hat{\mathrm{I}} \tag{17}$$

with $\hat{\mathrm{I}} = \mathbf{i}\sigma_z$ and σ_z as the Pauli spin matrix.

In this way we can express the double Doppler boost of an electron at rest from the FFG to the SG as a Lorentz boost of $E\hat{1}$ within a biquaternion metric or a Pauli spin matrix context. The two options to Doppler boost an electron from the FFG to the SG can be cast in the language of electron spin.

But for the electron that we Doppler boosted from the free fall grid to the stationary grid this description will not do because the wavelength connected momentum is, in this format, a real space like vector and not a scalar. A hidden momentum should be integrated in the equations as a scalar time-like quantity, which is not the case here. But we have went from the double scalar operator $U_0 \to U_0 e^{\pm\psi} = U_{\phi} \pm cp_{\phi}$ to the single matrix operator $P^{\phi} = (E\hat{1})^{L} = U^{-1}(E\hat{1})U^{-1}$. This operator can be cast in the format of an helicity rotator with $U = e^{H\psi/2}$, with

$$H = \frac{\mathbf{p}\cdot\hat{\mathbf{K}}}{\mathbf{i}p} \tag{18}$$

The two different Doppler boosts of an electron from the FFG to the SG can be looked at as two hidden helicities of the electron at rest in SG. With a particle at rest on the free fall grid $P = E\hat{1}$ we have the operator that will double Doppler boost the particle on the stationary grid as a Lorentz boost

$$P^L = U^{-1}PU^{-1} = e^{-H\frac{\psi}{2}}Pe^{-H\frac{\psi}{2}} = p_{0\psi}\hat{1} + p_{1\psi}\hat{\mathrm{I}}. \tag{19}$$

We are not satisfied with the result, because the gravitational hidden momentum $p_{1\psi}$ should be a scalar, time-like quantity, not a space-like vector quantity. To achieve that, we have to move on, from Pauli-spin environment to a Dirac spin ensemble.

V. INTRODUCING THE DIRAC LEVEL ENVIRONMENT

In paper [5] we worked out a biquaternion version of the quantum symbolism and approach. Starting with

$$\begin{aligned} P &= p_0\hat{1} + p_1\hat{\mathrm{I}} + p_2\hat{\mathrm{J}} + p_3\hat{\mathrm{K}} = p_0\hat{1} + \mathbf{p}\cdot\hat{\mathbf{K}} \\ &= \begin{bmatrix} p_0 + \mathbf{i}p_1 & p_2 + \mathbf{i}p_3 \\ -p_2 + \mathbf{i}p_3 & p_0 - \mathbf{i}p_1 \end{bmatrix} = \begin{bmatrix} P_{00} & P_{01} \\ P_{10} & P_{11} \end{bmatrix}, \end{aligned} \tag{20}$$

we defined $P^T = -p_0\hat{1} + \mathbf{p}\cdot\hat{\mathbf{K}}$ and $P^P = p_0\hat{1} - \mathbf{p}\cdot\hat{\mathbf{K}}$. We had the norm of P as $P^T P = -E^2\hat{1}$, which served as the basis of the Klein-Gordon Equation $\partial^T\partial\Psi = -E^2\hat{1}\Psi$, with a two column spinor Ψ. In this form it gives two identical scalar equation, but if on adds the electromagnetic four momentum, a Pauli spin element appears and the two column spinor then represents the two valueness of the spin state, up and down. We used the guideline that all higher form equations should eventually be reducible to this Klein-Gordon basic Energy Equation $P^T P = -E^2\hat{1}$.

We then defined the Weyl momentum or slash momentum $\not{P}$ as

$$\not{P} = \begin{bmatrix} 0 & P \\ -P^T & 0 \end{bmatrix} \tag{21}$$

with the energy momentum four vector as $\not{P} = p_0\gamma_0 + \mathbf{p}\cdot\boldsymbol{\gamma}$. The Weyl or chiral equation arises from the energy momentum quadratic $\not{P}\not{P} = E^2\not{1}$.

$$\not{P}\not{P} = \begin{bmatrix} 0 & P \\ -P^T & 0 \end{bmatrix}\begin{bmatrix} 0 & P \\ -P^T & 0 \end{bmatrix} = \begin{bmatrix} -PP^T & 0 \\ 0 & -P^T P \end{bmatrix} = \begin{bmatrix} E^2\hat{1} & 0 \\ 0 & E^2\hat{1} \end{bmatrix} = E^2\not{1} \tag{22}$$

which can be written as

$$\begin{bmatrix} -E\hat{1} & P \\ -P^T & -E\hat{1} \end{bmatrix} \begin{bmatrix} E\hat{1} & P \\ -P^T & E\hat{1} \end{bmatrix} = \begin{bmatrix} -E^2\hat{1} - PP^T & -EP+PE \\ -P^TE+EP^T & -P^TP-E^2\hat{1} \end{bmatrix} = \begin{bmatrix} KGE & 0 \\ 0 & KGE \end{bmatrix} \tag{23}$$

This can be written as $(\not{P} - E\not{1})(\not{P} + E\not{1}) = 0$ and it might seem that we can split this into $(\not{P} - E\not{1}) = 0$ and $(\not{P} + E\not{1}) = 0$, but that is mathematically useless because it means

$$\begin{bmatrix} -E\hat{1} & P \\ -P^T & -E\hat{1} \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \tag{24}$$

so this can only be true if everything is zero. Dirac found a way to make it meaningful by adding blenders. Technically these are called spinors of matter wave functions, but their simple purpose is to blend the elements of the matrices we want to split in order to have meaningful non-zero results that can be reduced to the Klein-Gordon condition. So lets give our blender Ψ the sub-blenders A and B as in

$$\begin{bmatrix} -E\hat{1} & P \\ -P^T & -E\hat{1} \end{bmatrix} \begin{bmatrix} A \\ B \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \tag{25}$$

resulting in the two equations

$$-E\hat{1}A + PB = 0 \tag{26}$$

$$P^TA - E\hat{1}B = 0 \tag{27}$$

so we have $\hat{1}A = \frac{1}{E}PB$ from the first equation, which we can insert in the second equation, giving $P^T\frac{1}{E}PB - E\hat{1}B = 0$, which results in $P^TPB - E^2\hat{1}B = 0$ or $(P^TP - E^2\hat{1})B = 0$, which is zero because of the Klein-Gordon energy condition $P^TP - E^2\hat{1} = 0$. We can do the same for the sub-blender A. This means that all sets of values $\Psi = (A, B)$ for which equation-set (26) is valid, have connected values of P that fulfill the Klein-Gordon energy condition. Blenders are at the root of entanglement. To blend is to entangle, so if you don't want entanglement then try to solve the problem at hand without the blenders. We can't because then only the zero solution is available. The absolute crazy thing of course is that blenders work in real life, that one can do physics with them. It needed genius like Pauli and Dirac to come up with such an idea. Pauli blended spin-up and spin-down states, Dirac added the blending of electron-state and positron-state, so he blended particle and anti-particle. Only in blended or entangled conditions can equations work and solutions be found. The philosophical question raised by this situation is to what extend this blending in our mathematical physics reflects the reality in nature. To what extend is the condition of Schrödinger's cat, for which we can only find mathematical solutions as long as we blend the two possible conditions, dead or alive, itself blended. To what extend is the real cat in this blended condition existing as a mixture of being dead and alive at the same time? Until the moment that we decide to un-blend or segregate the solutions A, dead cat, and B, living cat?

In order to segregate or undo the blending, in order to be able to find either a dead cat or a living cat instead of a limbo-cat, we have to multiply the solutions with $\overline{\Psi} = (A^{\dagger}, -B^{\dagger})$, resulting in the scalar $\overline{\Psi}\Psi = (A^{\dagger}A - B^{\dagger}B)$. Only now we have the tools to realize a meaningful split of $(\not{P} - E\not{1})(\not{P} + E\not{1}) = 0$, written first as the valid energy equation $\overline{\Psi}(\not{P} - E\not{1})\Psi\overline{\Psi}(\not{P} + E\not{1})\Psi = 0$ and then split into $\overline{\Psi}(\not{P} - E\not{1})\Psi = 0$ and $\overline{\Psi}(\not{P} + E\not{1})\Psi = 0$, leading to the two option for the Weyl energy equations as $(\not{P} - E\not{1})\Psi = 0$ and $(\not{P} + E\not{1})\Psi = 0$. Now, the equation with the negative rest energy E is skipped, because unphysical and having the same solutions, and the Weyl Energy Equation reads $(\not{P} - E\not{1})\Psi = 0$. Then we realize that we want all the solutions of the combinations of $\not{P}$ and Ψ that fulfill these equations, a demand that can be translated into operator language. We are not looking for one particular solution $\not{P}$ but for all $\not{P}$'s, something that can be made explicit by changing $\not{P}$ into its operator $\hat{\not{P}}$ and calling it an eigenvalue problem of $\hat{\not{P}}$ acting on Ψ. Then we have the final Weyl Equation

$$\hat{\not{P}}\Psi = E\not{1}\Psi. \tag{28}$$

For the operator we can choose the Schrödinger representation $\hat{\not{P}} = -\mathbf{i}\hbar\not{\partial}$ and a four column spinor or blender Ψ. The four column spinor represents the particle and anti-particle in their spin-up and spin-down states. In the Weyl equation, these are all in the blended state. Once solutions are found, the process of undoing the blending can take place, called reduction of the wave package, which leads to statistical predictions regarding the outcome of measurements.

In the slightly more complicated Dirac version of $\not{P}$ we get $\not{P} = p_0\beta_0 + \mathbf{p}\cdot\boldsymbol{\gamma}$. We still have the quadratic $\not{P}\not{P} = E^2\not{1}$ as $(p_0\beta_0 + \mathbf{p}\cdot\boldsymbol{\gamma})^2 = E^2\not{1}$, in matrix form as

$$\begin{bmatrix} p_0\hat{1} & \mathbf{p}\cdot\hat{\mathbf{K}} \\ -\mathbf{p}\cdot\hat{\mathbf{K}} & -p_0\hat{1} \end{bmatrix}\begin{bmatrix} p_0\hat{1} & \mathbf{p}\cdot\hat{\mathbf{K}} \\ -\mathbf{p}\cdot\hat{\mathbf{K}} & -p_0\hat{1} \end{bmatrix} = \begin{bmatrix} (p_0^2+\mathbf{p}^2)\hat{1} & 0 \\ 0 & (p_0^2+\mathbf{p}^2)\hat{1} \end{bmatrix} = E^2\not{1} \tag{29}$$

This leads to the valid split $(\not{P} - E\not{1})(\not{P} + E\not{1}) = 0$ as $(p_0\beta_0 + \mathbf{p}\cdot\boldsymbol{\gamma} - E\not{1})(p_0\beta_0 + \mathbf{p}\cdot\boldsymbol{\gamma} + E\not{1}) = 0$. From these two options, the positive rest energy part can be used to arrive at the Dirac equations

$$(\hat{p}_0\beta_0 + \hat{\mathbf{p}}\cdot\boldsymbol{\gamma})\Psi = E\not{1}\Psi. \tag{30}$$

VI. DOPPLER BOOSTING THE DIRAC PARTICLE FROM THE FREE FALL GRID ONTO THE STATIONARY GRID

On the Pauli level we could use the Helicity rotator to Doppler boost the de Broglie particle from the free fall grid onto the stationary grid. At the Dirac level we have the hyperbolic rotator

$$\not{1} e^{\frac{\not{p}}{E}\psi} = \not{1}\cosh\psi + \frac{\not{p}}{E}\sinh\psi, \tag{31}$$

with

$$E\not{1} e^{\frac{\not{p}}{E}\psi} = E\not{1}\cosh\psi + \not{p}\sinh\psi, \tag{32}$$

and

$$\not{p} e^{\frac{\not{p}}{E}\psi} = \not{p}\cosh\psi + E\not{1}\sinh\psi. \tag{33}$$

The effect of this rotator on $\not{p}$ can be put in matrix form as

$$\not{p}_\phi = \not{p} e^{\frac{\not{p}}{E}\psi} = \begin{bmatrix} (\gamma_\phi\beta_\phi E + \gamma_\phi p_0)\hat{1} & \gamma_\phi \mathbf{p}\cdot\hat{\mathbf{K}} \\ -\gamma_\phi \mathbf{p}\cdot\hat{\mathbf{K}} & (\gamma_\phi\beta_\phi E - \gamma_\phi p_0)\hat{1} \end{bmatrix} = \tag{34}$$

$$\begin{bmatrix} (\mathbf{i}m_\phi v_\phi + \gamma_\phi p_0)\hat{1} & \gamma_\phi \mathbf{p}\cdot\hat{\mathbf{K}} \\ -\gamma_\phi \mathbf{p}\cdot\hat{\mathbf{K}} & (\mathbf{i}m_\phi v_\phi - \gamma_\phi p_0)\hat{1} \end{bmatrix} = \mathbf{i}m_\phi v_\phi\not{1} + \gamma_\phi p_0\hat{\beta}_0 + \gamma_\phi \mathbf{p}\cdot\hat{\boldsymbol{\gamma}}. \tag{35}$$

If we apply this to a particle at rest on the free fall grid, we get

$$\not{p}_{+\phi} = \not{p} e^{\frac{\not{p}}{E}\psi} = \begin{bmatrix} (\gamma_\phi\beta_\phi E + \gamma_\phi p_0)\hat{1} & 0 \\ 0 & (\gamma_\phi\beta_\phi E - \gamma_\phi p_0)\hat{1} \end{bmatrix} = \tag{36}$$

$$\begin{bmatrix} (\mathbf{i}m_\phi v_\phi + \gamma_\phi p_0)\hat{1} & 0 \\ 0 & (\mathbf{i}m_\phi v_\phi - \gamma_\phi p_0)\hat{1} \end{bmatrix} = \mathbf{i}m_\phi v_\phi\not{1} + \gamma_\phi p_0\hat{\beta}_0 \tag{37}$$

and the inverse

$$\not{p}_{-\phi} = \not{p} e^{-\frac{\not{p}}{E}\psi} = \begin{bmatrix} (-\gamma_\phi\beta_\phi E + \gamma_\phi p_0)\hat{1} & 0 \\ 0 & (-\gamma_\phi\beta_\phi E - \gamma_\phi p_0)\hat{1} \end{bmatrix} = \tag{38}$$

$$\begin{bmatrix} (-\mathbf{i}m_\phi v_\phi + \gamma_\phi p_0)\hat{1} & 0 \\ 0 & (-\mathbf{i}m_\phi v_\phi - \gamma_\phi p_0)\hat{1} \end{bmatrix} = -\mathbf{i}m_\phi v_\phi\not{1} + \gamma_\phi p_0\hat{\beta}_0. \tag{39}$$

The end result $\not{p}_{\pm\phi} = \not{p} e^{\pm\frac{\not{p}}{E}\psi} = \pm\mathbf{i}\gamma_\phi m_0 v_\phi\not{1} + \gamma_\phi p_0\hat{\beta}_0$ is promising, because now the hidden Doppler momentum $p_\phi = m_\phi v_\phi$ appears as a time-like scalar change of the Lorentz invariant but not any longer gravity invariant rest energy momentum $E\not{1}$. With $p_0^\phi = \gamma_\phi p_0 = \left(1 - \frac{\Phi}{c^2}\right) p_0$ and

$p_\phi = \gamma_\phi m_0 v_\phi = \left(1 - \frac{\Phi}{c^2}\right) m_0 v_\phi$ and $v_\phi = v_{escape}$, we have introduced the gravitational potential into the Dirac quantum environment. We showed a possibility of how to Doppler boost a Dirac particle $\not{P}$ from the free fall grid onto the stationary grid. The Doppler boost adds a two valueness rest-energy hidden momentum to the energy momentum of the Dirac particle. This particle will then also have a hidden de Broglie wavelength attached to it, justifying the use of the momentum operator in the Dirac environment. The square of its total rest energy momentum on the stationary grid will then be the two valued

$$\not{P}_{\pm\phi}\not{P}_{\pm\phi} = p_0^2 \not{1} \pm 2\mathbf{i}\gamma_\phi^2 \beta_\phi p_0^2 \hat{\beta}_0 = E^2 \not{1} \pm E_{hidden}^2 \hat{\beta}_0. \tag{40}$$

Let us recapture the result we have. We started with Doppler boosting a de Broglie particle at rest from the FFG to the SG in a scalar fashion as

$$\frac{U_0}{c_0} e^{\pm\psi} = \gamma_\phi m_0 c_0 \pm \gamma_\phi m_0 v_\phi = m_\phi (c_0 \pm v_\phi) = \gamma_\phi p_0 \pm p_\phi = \frac{U_\phi}{c_0} \pm p_\phi \tag{41}$$

The two valued momentum that appeared is a hidden one on the SG so it should be a two valued scalar added to the time like energy momentum component of the de Broglie particle. We used the biquaternion version of the Pauli spin environment to incorporate the two valueness in a single description of a de Broglie particle. But then the extra momentum had to be space-like and thus non-hidden, so that didn't work. We then tried the same on the Dirac particle level $\not{P}$ and this gives some promising first results. The hidden momentum now appears as a time-like scalar quantity and the square of the Doppler boosted particle on the SG has obtained a hidden energy level. Because we have two options for the boost, we have two hidden energy levels relative to the original rest energy level. But we have two problems. We still have two different sets of Doppler boost equations, and not one single equation in which two two Doppler boost options are integrated. And the square of the boosted energy momentum does not look good. We can write the square of the boosted energy momentum calculation as

$$\not{P}_{\pm\phi}\not{P}_{\pm\phi} - E^2 \not{1} = \pm E_{hidden}^2 \hat{\beta}_0. \tag{42}$$

It should be clear that this doen't look good for the Weyl-Dirac Equations, who are based on $\not{P}\not{P} - E^2 \not{1} = 0$. The question arises if we can Doppler boost the Dirac Energy Equation from the free fall grid onto the stationary grid?

The above can be written as $\not{P} e^{\frac{\not{P}}{E}\psi} \not{P} e^{\frac{\not{P}}{E}\psi} - E^2 \not{1} = E_{hidden}^2 \hat{\beta}_0$ and $\not{P} e^{-\frac{\not{P}}{E}\psi} \not{P} e^{-\frac{\not{P}}{E}\psi} - E^2 \not{1} = -E_{hidden}^2 \hat{\beta}_0$. What we could try is mixing the Doppler boosts in the quadratic $\not{P}\not{P} = E^2 \not{1}$, which results in $\not{P}e^{\frac{\not{P}}{E}\Psi}\not{P}e^{-\frac{\not{P}}{E}\Psi}=E^2\not{1}$, an equation that is still valid and that guarantees the reduction to Klein-Gordon. The next step is to split it as $\left(\not{P}e^{\frac{\not{P}}{E}\Psi}-E\not{1}\right)\left(\not{P}e^{-\frac{\not{P}}{E}\Psi}+E\not{1}\right)=0$ and check if this is a valid energy equation. It turns out that it isn't. Calculations result in a rest term $2E^2 sinh\phi$, or $2E^2 cosh\phi$ if one changes the signs of the $E\not{1}$'s.

As a solution we could try to Doppler boost the particle's energy momentum together with its rest energy momentum, so use $\left(\not{P}-E\not{1}\right)e^{\frac{\not{P}}{E}\Psi}$ in some form. But this reduces to

$$\left(\not{P}-E\not{1}\right)e^{\frac{\not{P}}{E}\Psi}=\left(\not{P}-E\not{1}\right)e^{-\Psi}, \tag{43}$$

an energy equation that in the end doesn't add any extra information to $(\hat{\not{P}}-E\not{1})\Psi=0$. We conclude that by Doppler boosting the Dirac particle from the free fall grid onto the stationary grid, we either render the Dirac equations invalid or simply multiply it by a useless constant. In the next section we will try to find a solution by double the matrices, so by going to the Dirac particle-doublet level.

VII. FROM THE DIRAC LEVEL TO THE DIRAC DOUBLET LEVEL

When we double the Dirac matrices, we also double the spinors and we go from particle and anti-particle to the level of particle and anti-particle doublets: we enter the Yang-Mills level, if we can defined the YM-level as the Dirac equation doublets environment. So on the Pauli level we have a particle with spin-up and spin-down two valued spinor. On the Dirac level we have two Pauli-level equations, one for the particle and one for its anti-particle, so four valued spinors. On the Yang-Mills level we have two Dirac equations, one for a particle and one for its doublet, so eight value spinors. If our goal works on this level, then we do not just Doppler boost an electron from the free fall grid onto the stationary grid, but we also boost the anti-electron and their doublets, the electron-neutrino's.

First we have to show that the double version still reduces to the Weyl-Dirac equations. Without this, we have no valid equation to start with on the free fall grid, our Special Relativity environment where the Dirac Equation is valid. We define the YM momentum or double slash momentum $\not{\not{P}}$ as the trivial

$$\not{\not{P}} \equiv \begin{bmatrix} 0 & \not{P} \\ \not{P} & 0 \end{bmatrix} \tag{44}$$

and the related unity vector $\not{\mathbb{E}}$ as

$$\not{\mathbb{E}} \equiv \begin{bmatrix} 0 & \not{1} \\ \not{1} & 0 \end{bmatrix}. \tag{45}$$

The related energy momentum quadratic $\not{\mathbb{P}}\not{\mathbb{P}} = E^2\not{\mathbb{E}}$ results in

$$\not{\mathbb{P}}\not{\mathbb{P}} = \begin{bmatrix} 0 & \not{P} \\ \not{P} & 0 \end{bmatrix} \begin{bmatrix} 0 & \not{P} \\ \not{P} & 0 \end{bmatrix} = \begin{bmatrix} \not{P}\not{P} & 0 \\ 0 & \not{P}\not{P} \end{bmatrix} = \begin{bmatrix} E^2\not{1} & 0 \\ 0 & E^2\not{1} \end{bmatrix} = E^2\not{\mathbb{E}} \tag{46}$$

This leads to the splitting in $(\not{\mathbb{P}} - E\not{\mathbb{E}})(\not{\mathbb{P}} + E\not{\mathbb{E}}) = 0$, from which the energy condition leading to the Weyl-Dirac equations can be derived as

$$(\not{\mathbb{P}} - E\not{\mathbb{E}})(\not{\mathbb{P}} + E\not{\mathbb{E}}) = \begin{bmatrix} -E\not{1} & \not{P} \\ \not{P} & -E\not{1} \end{bmatrix} \begin{bmatrix} E\not{1} & \not{P} \\ \not{P} & E\not{1} \end{bmatrix} = \begin{bmatrix} -E^2\not{1} + \not{P}\not{P} & 0 \\ 0 & \not{P}\not{P} - E^2\not{1} \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} = 0 \tag{47}$$

The trivial thing here is that we add nothing new, we just produced two identical versions of the Weyl-Dirac energy conditions, leading to the Klein-Gordon energy conditions. For the moment, this is a good thing because it means that we start with valid equations on the free fall grid. In order to arrive at a doublet version of the Dirac-Weyl equation we need a new set of blenders, the doublet $\Psi = (\Psi_1, \Psi_2)$, each of which represents a Dirac 4-spinor. Using the blenders, the energy equation $(\not{\mathbb{P}} - E\not{\mathbb{E}})(\not{\mathbb{P}} + E\not{\mathbb{E}}) = 0$ can be written as $\overline{\Psi}(\not{\mathbb{P}} - E\not{\mathbb{E}})\Psi\overline{\Psi}(\not{\mathbb{P}} + E\not{\mathbb{E}})\Psi = 0$, and this can be split into $\overline{\Psi}(\not{\mathbb{P}} - E\not{\mathbb{E}})\Psi = 0$ and $\overline{\Psi}(\not{\mathbb{P}} + E\not{\mathbb{E}})\Psi = 0$, leading to the Dirac-Weyl doublet equation $(\not{\mathbb{P}} - E\not{\mathbb{E}})\Psi = 0$. If we demix the blenders, we produce two identical Dirac-Weyl equations, one for Ψ_1 and one for Ψ_2. Because the whole procedure is perfectly symmetric, we do not add any new information and we just produce a doublet of two identical particles. But the procedure works and is valid. It can be interpreted as an iteration relative to the Dirac method of producing the relativistic version of the Pauli spin equations. Where Dirac went from non-relativistic to relativistic in the Special Relativity sense, we try to go from a flat space-time Special Relativity environment to a gravity environment where Lorentz scalars aren't invariants anymore, due to 'curvature'-effects. We are trying to do quantum mechanics outside the Poincaré group environment because we change the rest energy of de Broglie-Dirac particles by Doppler boosting them from the free fall grid onto the stationary grid. On the free fall grid, we have quantum mechanics within the Poincaré group environment. On the stationary grid, this needs adjustment.

We leave the Poincaré group environment and introduce asymmetry into the prepared Weyl-

Dirac doublet approach by defining the boosted energy momentum tensor as

$$\not{\mathbb{P}}_{+\phi} = \begin{bmatrix} 0 & \not{P} e^{\frac{\not{P}}{E}\psi} \\ \not{P} e^{-\frac{\not{P}}{E}\psi} & 0 \end{bmatrix} \tag{48}$$

and it's inverse as

$$\not{\mathbb{P}}_{-\phi} = \begin{bmatrix} 0 & \not{P} e^{-\frac{\not{P}}{E}\psi} \\ \not{P} e^{\frac{\not{P}}{E}\psi} & 0 \end{bmatrix}. \tag{49}$$

We have $\not{\mathbb{P}}_{+\phi}\not{\mathbb{P}}_{-\phi} = \not{\mathbb{P}}\not{\mathbb{P}} = E^2\not{\mathbb{E}}$ and get the non-trivial but valid $(\not{\mathbb{P}}_{+\phi} - E\not{\mathbb{E}})(\not{\mathbb{P}}_{-\phi} + E\not{\mathbb{E}}) = 0$. By using the blender or spinor doublet $\Psi = (\Psi_1, \Psi_2)$ we arrive at the equation $(\not{\mathbb{P}}_{+\phi} - E\not{\mathbb{E}})\Psi = 0$. In this equation, written as

$$\begin{bmatrix} -E\not{1} & \not{P} e^{\frac{\not{P}}{E}\psi} \\ \not{P} e^{-\frac{\not{P}}{E}\psi} & -E\not{1} \end{bmatrix} \begin{bmatrix} \Psi_1 \\ \Psi_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \tag{50}$$

the doublet spinors Ψ_1 and Ψ_2 blend the two options for the Doppler boost from the free fall grid onto the stationary grid, boosts represented by $e^{\frac{\not{P}}{E}\psi}$ and $e^{-\frac{\not{P}}{E}\psi}$. Each of them is in an entangled Doppler boost state, resulting for example in two different rest energy levels relative to the free fall rest energy E.

We now have solved the two problems we had in the previous section. First, we have one operation $\not{\mathbb{P}}_{+\phi}$ for the two possible Doppler boosts of a single particle-doublet, and at the same time we got the inverse operation $\not{\mathbb{P}}_{-\phi}$. Second, we can reduce the energy momentum expressions to the Klein-Gordon condition.

But in this last equation $(\not{\mathbb{P}}_{+\phi} - E\not{\mathbb{E}})\Psi = 0$, we didn't Doppler boost E from the free fall grid to the stationary grid, so we haven't checked the most general possibility. In other words, we boosted $\not{\mathbb{P}}$, not the Dirac-Weyl condition $(\not{\mathbb{P}} - E\not{\mathbb{E}})$. For the last step, boosting the full $(\not{\mathbb{P}} - E\not{\mathbb{E}})$, we go to the matrix form and write

$$(\not{\mathbb{P}}_{+\phi} - E_{+\phi\not{\mathbb{E}}})(\not{\mathbb{P}}_{-\phi} + E_{-\phi}\not{\mathbb{E}}) = \begin{bmatrix} -E\not{1} e^{\frac{\not{P}}{E}\psi} & \not{P} e^{\frac{\not{P}}{E}\psi} \\ \not{P} e^{-\frac{\not{P}}{E}\psi} & -E\not{1} e^{-\frac{\not{P}}{E}\psi} \end{bmatrix} \begin{bmatrix} E\not{1} e^{-\frac{\not{P}}{E}\psi} & \not{P} e^{\frac{\not{P}}{E}\psi} \\ \not{P} e^{-\frac{\not{P}}{E}\psi} & E\not{1} e^{\frac{\not{P}}{E}\psi} \end{bmatrix} = \tag{51}$$

$$\begin{bmatrix} -E^2\not{1} + \not{P}\not{P} & 0 \\ 0 & \not{P}\not{P} - E^2\not{1} \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} = 0 \tag{52}$$

(53)

What this means is that if we start with the double version of the Dirac-Weyl energy condition on the free fall grid and Doppler boost it onto the stationary grid, we have the unchanged Dirac-Weyl energy condition back again. The energy version of the Klein-Gordon condition doesn't change under a boost from the FFG to the SG. The double valued Doppler boost of the Dirac-Weyl energy condition from the FFG to the SG can then lead to doublet equation as $\mathbb{P}_{+\phi}\Psi = E_{+\phi}\Psi$. Change the energy momenta for their operators and a Dirac-Weyl doublet wave equation for a FFG to SG boost results as $\hat{\mathbb{P}}_{+\phi}\Psi = E_{+\phi}\Psi$.

So we have found the Doppler boost for the particle doublets Weyl-Dirac equations from the free fall grid to the stationary grid as

$$\begin{bmatrix} -E\not{1}e^{\frac{\not{p}}{E}\psi} & \hat{\not{p}}e^{\frac{\not{p}}{E}\psi} \\ \hat{\not{p}}e^{-\frac{\not{p}}{E}\psi} & -E\not{1}e^{-\frac{\not{p}}{E}\psi} \end{bmatrix} \begin{bmatrix} \Psi_1 \\ \Psi_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \tag{54}$$

So what didn't work on the Dirac level, did work on a double version of the Dirac level, to boost the Dirac relativistic electron equation from the free fall grid into the stationary grid in a central field of gravity.

Two issues arise, first the interpretation of the doublet and second the related question if we shouldn't have Doppler boosted the doublet also from the free fall grid onto the stationary grid. Especially when Ψ_1 is to be interpreted as the Dirac representation of the electron-positron doublet, as $\Psi_1 = (e^-, e^+) = (e^-_\downarrow, e^-_\uparrow, e^+_\downarrow, e^+_\uparrow)$, we should ask ourselves if we shouldn't also Doppler boost the spinor from the FFG onto the SG.

If we write out equation (54) for a particle initially at rest in the free fall grid, with rest mass m_0 and inertial energy $p_0 = \mathbf{i}U_0/c_0$, and then boosted onto the stationary grid where we have a gravitatinal potential Φ, we get

$$\begin{bmatrix} \gamma_\phi\left(p_0\hat{\beta}_0 + \beta_\phi E\not{1}\right)\Psi_2 \\ \gamma_\phi\left(p_0\hat{\beta}_0 - \beta_\phi E\not{1}\right)\Psi_1 \end{bmatrix} = \begin{bmatrix} \gamma_\phi\left(E\not{1} - \beta_\phi p_0\hat{\beta}_0\right)\Psi_1 \\ \gamma_\phi\left(E\not{1} + \beta_\phi p_0\hat{\beta}_0\right)\Psi_2 \end{bmatrix} \tag{55}$$

and using $\beta_\phi E = \beta_\phi p_0 = \mathbf{i}m_0 v_\phi$ for a rest particle, with $v_\phi = v_{escape}$ we get

$$\begin{bmatrix} \left(p_0\hat{\beta}_0 + \mathbf{i}m_0 v_\phi\not{1}\right)\Psi_2 \\ \left(p_0\hat{\beta}_0 - \mathbf{i}m_0 v_\phi\not{1}\right)\Psi_1 \end{bmatrix} = \begin{bmatrix} \left(E\not{1} - \mathbf{i}m_0 v_\phi\hat{\beta}_0\right)\Psi_1 \\ \left(E\not{1} + \mathbf{i}m_0 v_\phi\hat{\beta}_0\right)\Psi_2 \end{bmatrix}. \tag{56}$$

If we disentangle Ψ_1 and Ψ_2 by using the above equations, we get the invariant quadratic rest energy condition that is identical to the free fall rest energy condition. And if we only boost $\mathbb{P}$ and not $E\not{\mathbb{E}}$ we get

$$\begin{bmatrix} \left(p_0(1-\frac{\Phi}{c^2})\hat{\beta}_0\right)\Psi_2 \\ \left(p_0(1-\frac{\Phi}{c^2})\hat{\beta}_0\right)\Psi_1 \end{bmatrix} = \begin{bmatrix} \left(E\not{1} - \mathbf{i}m_0 v_\phi(1-\frac{\Phi}{c^2})\hat{\beta}_0\right)\Psi_1 \\ \left(E\not{1} + \mathbf{i}m_0 v_\phi(1-\frac{\Phi}{c^2})\hat{\beta}_0\right)\Psi_2 \end{bmatrix}. \tag{57}$$

Now, as for the interpretation of the doublet of the electron spinor, Ψ_2, we cannot presume that this is the neutrino spinor as in the Standard Model doublet. We boosted the electron from the free fall grid onto the stationary grid in central field of gravity. The blending concerns the double valueness of the Doppler boost. We thereby 'rotated' energy out of the inertial energy into the rest energy and/or vise verse. We can interpret this as an effect of space-time curvature on the Dirac-Weyl particle-doublet. Interestingly, if this was done in a $v_\phi \approx c_0$ environment, then one particle doublet would get a double rest energy and the other particle doublet would get almost zero rest energy. An interesting question is if this approach could be used to originally get rest mass into particles while boosting them from an extreme gravity, Planck-scale environment into free space.

VIII. CONCLUSION REGARDING THE DOPPLER BOOST OF A DE BROGLIE PARTICLE FROM THE FFG ONTO THE SG

In our restricted approach towards gravity, it proved very difficult to Doppler boost a de Broglie particle in such a way from the FFG onto the SG that the Klein-Gordon condition remained valid. We only managed it, from the math-phys perspective, on the Dirac-Weyl doublet level. On the Pauli level and the Dirac level, it proved impossible to keep the Klein-Gordon condition intact and not end up with the contradiction of a space-time version of the invisible gravitational Doppler momentum. In order to incorporate the two valueness of the hidden Doppler momentum we turned to the quantum heuristics of doubling the dimensions or matrices, so we borrowed the spin heuristics. In the end, this worked out on the Dirac doublet level. Thus far, this is all just theory and thus speculation. We haven't made any claims regarding real doublets, like the Standard Model electron-neutrino doublet. The doublet of this paper has nothing to do with this Standard Model doublet.

The most direct interpretation of our doublet starts with the identical Dirac-Weyl doublet of equation $(\not{\mathbb{P}} - E\not{\mathbb{E}})\Psi = 0$ with $\Psi = (\Psi_1, \Psi_2)$ and $\Psi_1 = \Psi_2 = (e^+, e^-)$, with $\Psi_1 = (\Psi_{11}, \Psi_{12}) = (e_1^+, e_1^-)$ and $\Psi_2 = (\Psi_{21}, \Psi_{22}) = (e_2^+, e_2^-)$. We Doppler boost this Dirac particle doublet of two identical (e_2^+, e_2^-) pairs from the free fall grid onto the stationary grid, but with a two valueness for the applied Doppler boost. This results in two slightly different but entangled Dirac electron-positron pairs. If we use equation (56) and the fact that $\beta_\phi = \frac{v_{escape}}{c}$, we get for earth the value

$\beta_\phi = 3,73 \cdot 10^{-5}$ and

$$\Psi_{21} = \frac{1-\beta_\phi}{1+\beta_\phi}\Psi_{11} = 0,9999254\Psi_{11} \tag{58}$$

$$\Psi_{22} = -\frac{1+\beta_\phi}{1-\beta_\phi}\Psi_{12} = -1,0000746\Psi_{12}. \tag{59}$$

So if one electron-positron pair is used as a standard, then the other pair has slightly different values for its wave functions. Regarding the probabilities, we have $\overline{\Psi}(\not{\mathbb{P}} - E\not{\mathbb{E}})\Psi$, eventually leading to

$$|\Psi_{21}| = |\Psi_{11}|\sqrt{\frac{1-\beta_\phi}{1+\beta_\phi}} = 0,9999627\,|\Psi_{11}| \tag{60}$$

$$|\Psi_{22}| = |\Psi_{12}|\sqrt{\frac{1+\beta_\phi}{1-\beta_\phi}} = 1,0000373\,|\Psi_{12}|. \tag{61}$$

So if the first doublet is taken as the norm, then the second doublet should have a small gravitational Doppler shift. If the first was an electron positron doublet, then the second doublet should have a slightly gravitational red shifted electron matter wave or probability density and a slightly gravitational blue shifted positron matter wave or probability density.

This should then be the case for all Dirac particle-anti-particle pair doublets. If it would be possible to connect this outcome to a prediction, then a pragmatic approach towards quantum gravity would be firmly established. The prediction should then focus on slightly different behavior of electron-positron pairs, relative to each other, a small uncertainty in electron-positron pair behavior. The problem with the above analysis is that it concerns Dirac pairs at rest, which is not a realistic experimental situation. Of course, equation (54) is very general and should work for all velocities on the free fall grid. Extra calculations might lead to more realistic starting points for arriving at predictions.

If it is already that difficult in such a simple model as our FFG to SG approach, to arrive at an integration of gravity with quantum axioms like those of de Broglie, then we expect it even more complicated in the environment of the Schwarzschild metric. We started with such a limited goal, just Doppler boost the de Broglie scalar electron hypothesis from the free fall gravity free grid onto the stationary grid in a central field of gravity.

What we still have to explore is the inclusion of the spinor in the Doppler boost from the free fall grid onto the stationary grid in a central field of gravity.

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