The Galois Solvable Fourth Roots of Reality

Wheeler-Feynman Spinor Qubits → Einstein's Gravitational Field

Spin Network Pre-Geometry for Dummies

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Abstract

Local observers are defined by orthonormal "non-holonomic" (aka "non-coordinate") tetrad gravity fields (Cartan's "moving frames"). The tetrads are spin 1 vector fields under the 6-parameter homogeneous Lorentz group $SO_{1,3}$ of Einstein's 1905 special relativity. You can think of the tetrad gravity fields as the square roots of Einstein's 1916 spin 2 metric tensor gravity fields. We will see that we must also allow for spin 0 and spin 1 gravity because the spin 1 tetrads, in turn, are Einstein-Podolsky-Rosen entangled quantum states of pairs of 2-component Penrose-Rindler qubits in the quantum pre-geometry. The Wheeler-Feynman qubits are the square roots of the advanced and retarded null tetrads and can therefore be called the Galois solvable fourth roots of reality. The spherical wavefront tetrads are then formally the Bell pair states of quantum information theory. Penrose's Cartesian tetrads are a different choice from mine here. The different tetrad choices correspond to the different contours around the photon propagator poles in the complex energy plane of quantum electrodynamics. Both of his spinors in his spin frame are retarded in the same light cone, e.g. the forward cone. It seems that Penrose and Rindler implicitly answered Wheeler's question of how IT comes from BIT, but no one realized it until now.

Minkowski space-time stereographic projection, light rays obey[2]

$$ds^2 = c^2dt^2 - dr^2 - r^2d\theta^2 - r^2\sin^2\theta d\phi^2 \to 0 \tag{1.1}$$

$$c^2dt^2 - dr^2 = (cdt - dr)(cdt + dr) \equiv d\vartheta_{ret}d\vartheta_{adv} \tag{1.2}$$

$$A(r) \equiv 4\pi r^2 \tag{1.3}$$

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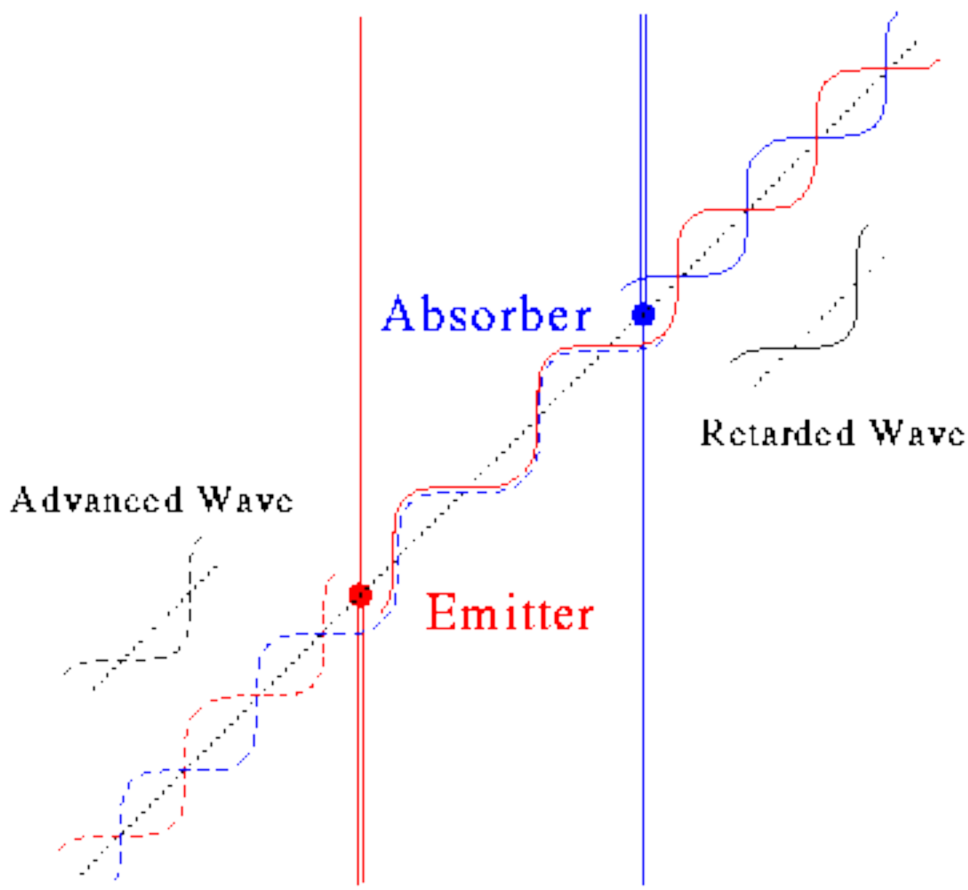
[2] I am following Penrose & Rindler's "Spinors and space-time" (Cambridge) but making changes from their Cartesian tetrads to spherical wave front tetrads.

is always the area of a spherical wave front from the space time event where the relative Schwarzschild radial coordinate locating the light cone of interest at an Einstein "local coincidence" (Hole Problem 1918) $r = 0$ [3]. Curvature and torsion are relations between light cones at neighboring local coincidences. All bare manifold points connected by the same active diffeomorphism form a gauge invariant equivalence class corresponding to the same locally objective invariant "local coincidence" a bona-fide "geometrical object" independent of the local coordinate labels. This distinction is not needed in Einstein's 1905 Special Relativity in the absence of curvature and possibly torsion.

Retro-causal "destiny" advanced spherical light waves propagate *positive energy* from the point-like emitter backwards in time along the future emitter's past light cone to a past absorber. This is different from Feynman's anti-particle with *negative energy* propagated along the past light cone S^{-} of the emitter. Causal "history" retarded spherical light waves propagate positive energy along the past emitter's future light cone S^{+} to a future absorber. For example, in John Cramer's Transactional Picture[4]



[3] This works even in curved spacetime where it is understood that r is small compared to the local curvature scale.
[4] http://www.npl.washington.edu/npl/int_rep/dtime/node7.html

$$\frac{1}{c^2}\left(\frac{dr}{dt}\right)^2+\frac{A}{4\pi c^2}\left(\left(\frac{d\theta}{dt}\right)^2+\sin^2\theta\left(\frac{d\phi}{dt}\right)^2\right)=1 \tag{1.4}$$

Retarded and advanced light rays obey

$$\begin{aligned}\tilde{\zeta}_{ret}&=\frac{\sqrt{A}}{4\pi}\frac{(d\theta+i\sin\theta d\phi)}{(c|dt|-dr)}\\ \tilde{\zeta}_{adv}&=-\frac{\sqrt{A}}{4\pi}\frac{(d\theta+i\sin\theta d\phi)}{(c|dt|+dr)}\end{aligned} \tag{1.5}$$

The precise value of the area of the wave fronts play no essential role and we normalize them away.

$$\begin{aligned}\zeta_{ret}&\equiv\frac{d\theta}{d\vartheta_{ret}}+i\sin\theta\frac{d\phi}{d\vartheta_{ret}}\\ \zeta_{adv}&\equiv\frac{d\theta}{d\vartheta_{adv}}+i\sin\theta\frac{d\phi}{d\vartheta_{adv}}\end{aligned} \tag{1.6}$$

$$\begin{aligned}&\zeta\equiv|\zeta|e^{i\Theta}\\ &|\zeta|=\sqrt{\left(\frac{d\theta}{d\vartheta}\right)^2+\sin^2\theta\left(\frac{d\phi}{d\vartheta}\right)^2}\\ &\tan\Theta=\sin\theta\frac{\frac{d\phi}{d\vartheta}}{\frac{d\theta}{d\vartheta}}\end{aligned} \tag{1.7}$$

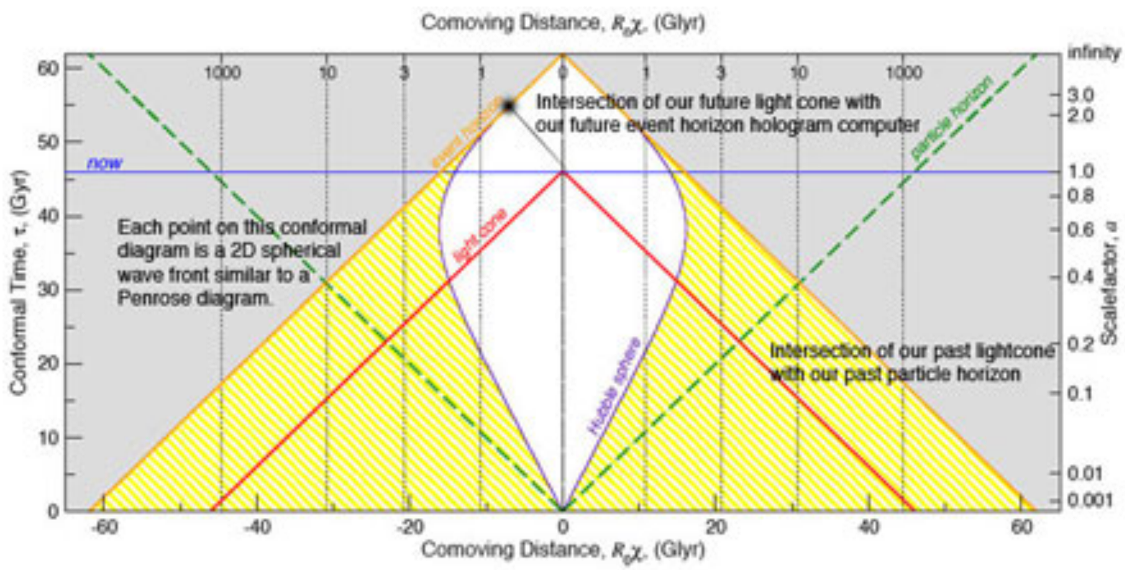
The qubit spinor components are the light cone projective coordinates

$$\zeta\equiv\frac{\xi_\uparrow}{\eta_\downarrow} \tag{1.8}$$

Define the qubit 2-component spinors

$$\begin{aligned} o_{adv} &\equiv \left(\xi_{adv}^{\uparrow}, \eta_{adv}^{\downarrow}\right) \equiv \left(o_{adv}^{A}\right) \\ \iota_{ret} &\equiv \left(\xi_{ret}^{\uparrow}, \eta_{ret}^{\downarrow}\right) \equiv \left(\iota_{ret}^{A}\right) \\ A &\equiv \uparrow, \downarrow \equiv \nearrow \swarrow \equiv \rightarrow \leftarrow \; etc \end{aligned} \tag{1.9}$$

The Wheeler-Feynman spin frame is then the dyad $\left(o_{adv}, \iota_{ret}\right)$. This is not the same as the choice made by Penrose and Rindler, though they could have done so, but were not thinking of the connection to the Wheeler-Feynman theory, which is now relevant because of the discovery of the dark energy accelerating our expanding universe from our future de Sitter event horizon in the precise sense of Fig 1.1 of Tamara Davis's 2004 PhD dissertation. It is our observer-dependent future event horizon that is the pixelated hologram screen, not our past particle horizon.[5]



[5] It is our subjective future horizon that is the Wheeler-Feynman perfect absorber infinite redshift surface. That is photons in our future light cone downshift to zero frequency in a finite distance in our *accelerating* expanding 3D space. In other words they disappear completely like in a permanent absorption. *One can think of this classical smooth stretching of the photon's wavelength with the scale factor a(t) in terms of Ehrenfest's theorem as the statistical mean of discrete random virtual inelastic scatterings and reemissions off quantum fluctuations of the dynamic spin 1 gravity tetrad vector fields.*

Define the orthonormal anholonomic intrinsic geometric object spherical wavefront Cartan 1-forms[6]

$$\begin{aligned} \hat{t} &\equiv cdt \\ \hat{r} &\equiv dr \\ \hat{\theta} &\equiv rd\theta \\ \hat{\phi} &\equiv r\sin\theta d\phi \end{aligned} \tag{1.10}$$

The local Minkowski space-time of LIFs in accord with the Einstein Equivalence Principle (EEP) is then

$$ds^2 = \hat{t}\otimes\hat{t} - \hat{r}\otimes\hat{r} - \hat{\theta}\otimes\hat{\theta} - \hat{\phi}\otimes\hat{\phi} \tag{1.11}$$

Define the *Wheeler-Feynman spherical wave front* null tetrads[7]

$$\begin{aligned} \ell_{adv} &\equiv \frac{1}{\sqrt{2}}\left(\hat{t}+\hat{r}\right) \\ n_{ret} &\equiv \frac{1}{\sqrt{2}}\left(\hat{t}-\hat{r}\right) \\ m &\equiv \frac{1}{\sqrt{2}}\left(\hat{\theta}-i\hat{\phi}\right) \\ \bar{m} &\equiv \frac{1}{\sqrt{2}}\left(\hat{\theta}+i\hat{\phi}\right) \end{aligned} \tag{1.12}$$

Recall that the phase of a far field $\sim r^{-1}$ spherical wave (macro-quantum coherent state of real transverse polarized photons) outside the cell of phase space in non-dispersive vacuum is $\sim k(ct \pm r)$. If the wave is in a dispersive medium, we have a index of refraction response function $\tilde{n}(\vec{k},\omega)$. Hence, the iso-phase fronts are much more complicated $\sim\left(\omega t/\tilde{n}(\vec{k},\omega) \pm kr\right)$ with group velocity for energy transport $\vec{\nabla}_{\vec{k}}\omega$. The non-

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[6] They have, of course, the usual dual tangent vectors.

[7] http://en.wikipedia.org/wiki/Newman–Penrose_formalism

"At each point, a tetrad (set of four vectors) is introduced. The first two vectors, n^μ and l^μ are just a pair of standard (real) null vectors such that $n^\mu l_\mu = 1$. For example, we can think in terms of spherical coordinates, and take n^μ to be the outgoing null vector, and l^μ to be the ingoing null vector."

http://www.scholarpedia.org/article/Newman-Penrose_formalism radiative near fields are macro-quantum coherent states of virtual photons inside the cell of phase space and both inside and outside the local light cones where $\omega \neq ck$.

Therefore, from the EEP. the *gyro-stabilized zero g-force LIF inertial frame observer* metric components at the origin of the local light cone of interest are approximately (close to the center of mass of the detector)[8]

$$
\begin{aligned}
\eta_{ab} &= \ell_{adv(a)} n_{ret(b)} + n_{ret(a)} \ell_{adv(b)} - m_a \bar{m}_b - \bar{m}_a m_b \\
&\approx \begin{matrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{matrix}
\end{aligned}
\tag{1.13}
$$

I now use the subtle Penrose "abstract index notation" a form of short-hand for local coordinate-independent intrinsic geometric objects – not to be confused with components relative to a local coordinate patch. This short hand erases some important physical information I will return to later, but it shows an interesting formal analogy, if not a proportionality to the Bell entangled states of quantum information theory. Also note that Penrose's Cartesian tetrads are a different choice from mine here. Both of his spinors in his spin frame are retarded in the same light cone, e.g. the forward cone. In contrast, here we have positive energy support on both the future light cone for the history spinor and on the past light cone for the destiny spinor for the same local point-like emitter in ordinary space. This is consistent with Dirac's late 1930's solution of classical radiation reaction "jerk" coming from the future absorber. Indeed, the response of the future absorbers (Feynman's influence functional) explains the zero point virtual photons hence the cosmological dark energy as essentially coming back to us from our future event horizon as a kind of Hawking-Unruh advanced blackbody radiation of temperature $\sim c^2 / R_{Hubble} \sim 1 \times \text{nanometer} \times \sec^{-2}$. The Wheeler-Feynman null tetrads are then 2-qubit spinor strings

$$
\begin{aligned}
\ell^a_{adv} &\equiv o^A_{adv} \bar{o}^{A'}_{adv} \\
n^a_{ret} &\equiv \iota^A_{ret} \bar{\iota}^{A'}_{ret} \\
m^a &\equiv o^A_{adv} \bar{\iota}^{A'}_{ret} \\
\bar{m}^a &\equiv \iota^A_{ret} \bar{o}^{A'}_{adv}
\end{aligned}
\tag{1.14}
$$

[8] Even in the presence of curvature and torsion tensor fields.

The spherical wavefront tetrads are then formally the Bell pair states of quantum information theory

$$\begin{aligned}
\hat{t}^a &= \frac{1}{\sqrt{2}}\left(o^A_{adv}o^{A'}_{adv} + \iota^A_{ret}\iota^{A'}_{ret}\right) \\
\hat{r}^a &= \frac{1}{\sqrt{2}}\left(o^A_{adv}o^{A'}_{adv} - \iota^A_{ret}\iota^{A'}_{ret}\right) \\
\hat{\theta}^a &= \frac{1}{\sqrt{2}}\left(o^A_{adv}\iota^{A'}_{ret} + \iota^A_{ret}o^{A'}_{adv}\right) \\
\hat{\phi}^a &= \frac{1}{\sqrt{2}}\left(o^A_{adv}\iota^{A'}_{ret} - \iota^A_{ret}o^{A'}_{adv}\right)
\end{aligned} \tag{1.15}$$

Of course, the reality is more complicated, once we introduce the Newman-Penrose EPR entanglement correlation coefficients, e.g.

$$\ell^a_{adv} = \Xi^a_{advA,advA'}o^A_{adv}o^{A'}_{adv} \tag{1.16}$$

Appendix A

Galois Theory

Finite analytical solutions of polynomials higher than the 4th degree do not exist. That is, no formulas with a finite number of terms, arithmetic operations and nth roots (aka "solution by radicals").

"The key element of Galois' insight is considering the rearrangements, more properly called the permutations, of the roots having the property that any algebraic equation satisfied by the roots remains satisfied after the roots have been permuted." Stephen Hawking "God Created The Integers" p. 805

This puzzle caused Galois to invent group theory, at first with the finite discrete permutation group that is the skeleton of the continuous groups, i.e. the method of Young Patterns in Herman Weyl's "Theory of Groups and Quantum Mechanics" (Dover).

"Galois demonstrated that the general polynomial equation of degree n could be solved by radicals, if and only if every subgroup N of the group of permutations Sn is a normal subgroup. Then he demonstrated that every subgroup of Sn is normal for all $n \le 4$ *, but not for any* $n \ge 5$ *."* Hawking again.

That the qubit spinors are the 4th roots of Einstein's metric tensor gravity field intuitively resonates with this to my mind suggesting something deep why our *classical* spacetime has only 4 dimensions – string theory still speculative. Of course the hologram principle suggests that our future 2D + 1 event horizon is the source of us as its retrocausal

Wheeler-Feynman images. Ultimately this traces back to Gerardus ‘t Hooft’s crazy idea. Is it crazy enough to be true? Gerardus, of course, can pass the buck to Hawking and Unruh who can pass it on to Bekenstein, but the buck stops with John Archibald Wheeler’s IT FROM BIT.