Broken Gauge Invariance and Nonsymmetric Stress-Energy Tensors

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Draft #3C

"It baffled me how people could resist math's gorgeousness, but people did, and people do. The fire of its purity drives them away, the purity of the fire, unmixed with the heaviness of unnecessitated being." p. 97, "The Properties of Light", Rebecca Goldstein.

1. Classical Gauge Invariance Revisited

For simply connected geometry[1]

$$\vec{B} = \vec{\nabla} \times \vec{A}$$
$$\vec{\nabla} \cdot \vec{B} = 0 \quad \textbf{(1.1)}$$

$$\frac{\partial \vec{B}}{\partial t} + \vec{\nabla} \times \vec{E} = 0 \quad \textbf{(1.2)}$$

Substitute (1.1) into (1.2). To avoid confusion of the different EM unit conventions, I take c = 1.[2]

$$\frac{\partial}{\partial t}\left(\vec{\nabla} \times \vec{A}\right) + \vec{\nabla} \times \vec{E} = 0$$
$$\vec{\nabla} \times \left(\frac{\partial \vec{A}}{\partial t} + \vec{E}\right) = 0$$
$$\frac{\partial \vec{A}}{\partial t} + \vec{E} = -\vec{\nabla}\phi \quad \textbf{(1.3)}$$
$$\vec{\nabla} \times \left(\frac{\partial \vec{A}}{\partial t} + \vec{E}\right) = -\vec{\nabla} \times \vec{\nabla}\phi = 0$$
$$\vec{E} = -\vec{\nabla}\phi - \frac{\partial \vec{A}}{\partial t}$$

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[1] "Geometry, Particles, and Fields," Bjorn Felsager, Springer-Verlag, New York (1998).

[2] therefore, the convention we use is that space and time are measured in the same units with the speed of classical light in a vacuum free of ordinary matter as the conversion factor

$$\begin{aligned}
&\frac{\rho}{\varepsilon_0} = \vec{\nabla}\cdot\vec{E} = \vec{\nabla}\cdot\left(-\vec{\nabla}\phi - \frac{\partial\vec{A}}{\partial t}\right) = -\vec{\nabla}^2\phi - \frac{\partial}{\partial t}\vec{\nabla}\cdot\vec{A} \\
&-\frac{\vec{j}}{\varepsilon_0} = \frac{\partial\vec{E}}{\partial t} - \vec{\nabla}\times\vec{B} = \frac{\partial}{\partial t}\left(-\vec{\nabla}\phi - \frac{\partial\vec{A}}{\partial t}\right) - \vec{\nabla}\times\vec{\nabla}\times\vec{A} \\
&= -\vec{\nabla}\frac{\partial\phi}{\partial t} - \frac{\partial^2\vec{A}}{\partial t^2} - \vec{\nabla}\left(\vec{\nabla}\cdot\vec{A}\right) + \vec{\nabla}^2\vec{A}
\end{aligned} \tag{1.4}$$

$$\begin{aligned}
&\left(\nabla^2 - \frac{\partial}{\partial t^2}\right)\phi = -\frac{\rho}{\varepsilon_0} - \frac{\partial}{\partial t}\left[\vec{\nabla}\cdot\vec{A} + \frac{\partial\phi}{\partial t}\right] \\
&\left(\nabla^2 - \frac{\partial}{\partial t^2}\right)\vec{A} = -\frac{\vec{j}}{\varepsilon_0} - \vec{\nabla}\left[\vec{\nabla}\cdot\vec{A} + \frac{\partial\phi}{\partial t}\right] \\
&\partial^\lambda\partial_\lambda A_\mu = -J_\mu - \partial_\mu\partial^\lambda A_\lambda \\
&\partial_\lambda = \left(\vec{\nabla}, \frac{\partial}{\partial t}\right) \\
&\partial^\lambda = \left(\vec{\nabla}, -\frac{\partial}{\partial t}\right) \\
&A_\lambda = \left(\vec{A}, -\phi\right)
\end{aligned} \tag{1.5}$$

The standard U(1) holonomic integrable gauge transformation[3] uses the arbitrary scalar field $\chi\left(\vec{r},t\right)$

$$\begin{aligned}
&\phi \to \phi' = \phi - \frac{\partial}{\partial t}\chi \\
&\vec{A} \to \vec{A}' = \vec{A} + \vec{\nabla}\chi \\
&A_\mu \to A_\mu' = A_\mu + \partial_\mu\chi \\
&\partial_\lambda = \left(\vec{\nabla}, \frac{\partial}{\partial t}\right) \\
&\partial^\lambda = \left(\vec{\nabla}, -\frac{\partial}{\partial t}\right) \\
&A_\lambda = \left(\vec{A}, -\phi\right) \\
&A^\lambda = \left(\vec{A}, \phi\right)
\end{aligned} \tag{1.6}$$

[3] Internal "rotation" symmetry at fixed space-time base point in the gauge fiber attached to that base point. Assuming integrability, i.e. symmetric mixed second order partial derivatives.

to keep the holonomic coordinate part of the electromagnetic field tensor $F_{\mu\nu}\left(\vec{r},t\right)_{holonomic}$ invariant

$$\vec{B}_{holonomic} = \vec{\nabla}\times\vec{A}$$
$$\vec{E}_{holonomic} = -\vec{\nabla}\phi - \frac{\partial\vec{A}}{\partial t} \qquad \mathbf{(1.7)}$$

Let us review the meaning of holonomic coordinates. Curved and torsioned space-time geometry is represented by a base manifold with a covering point set topology of overlapping open sets forming neighborhoods of base points. Each open neighborhood $\left\{x^{\mu}\right\}$ of base point P has a 1-1 map[4]

$$x^{\mu} \leftrightarrow q^{a}\left(x^{\mu}\right) \qquad \mathbf{(1.8)}$$

to a flat tangent space $\left\{q^{a}\right\}$ with a set of base tangent vectors[5] $\vec{e}_{\mu}$, whose *holonomic* components are $\partial q^{a}/\partial x^{\mu}$ in the natural basis $\partial/\partial x^{\mu}$. These maps are holonomic, i.e., "integrable" and "path independent" like conservative force fields in mechanics, if and only if the base tangent vectors are "irrotational" with zero vorticity or "curl" so that the mixed partial derivatives of the base to tangent maps are equal.[6] For example,

$$\frac{\partial^{2}q^{a}}{\partial x^{\mu}\partial x^{\nu}} = \frac{\partial^{2}q^{a}}{\partial x^{\nu}\partial x^{\mu}} \qquad \mathbf{(1.9)}$$

Let $\partial_{\mu} = \partial/\partial x^{\mu}$, the irrotational vortex free symmetry of the mixed partials is reexpressed as

$$\partial_{\nu}\vec{e}_{\mu} - \partial_{\mu}\vec{e}_{\nu} = 0 \qquad \mathbf{(1.10)}$$

In James Corum's classical anholonomic field theory[7], Einstein's symmetrical metric field $g_{\mu\nu}$ is supplemented with an anholonomic field $\Omega^{\lambda}_{\mu\nu}$, in which

$$\partial_{\nu}\vec{e}_{\mu} - \partial_{\mu}\vec{e}_{\nu} \neq 0 \qquad \mathbf{(1.11)}$$

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[4] "chart", the overlapping charts form an "atlas"

[5] Cartan moving frame of reference sweeping out relativistic "aether" hydrodynamic vector flow fields in the space-time geometry for the tangent bundle.

[6] Hagen Kleinert's work

[7] Based on the work of Gabriel Kron at GE in the 30's and 40's in which networks of rotating electrical machines form a non-Riemannian geometry on a nonintegrably anholonomically constrained surface embedded and folded inside a hyperspace- analogous to the 3D membranes we live inside of as shown in the M-theory picture in August 2000 Scientific American on "The Unseen Dimensions of the Universe".

So that equation (1.8) breaks down and we can no longer use the natural basis $\partial/\partial x^{\mu}$. Einstein's single-valued tetrads for the usual equivalence principle[8] used in conventional general relativity with topology conserving 1-1 global diffeomorphisms Diff(4) obey (1.11), but are holonomic at the tidal level, i.e. as shown by Hagen Kleinert

$$\partial_{\lambda}\partial_{\nu}\vec{e}_{\mu} - \partial_{\nu}\partial_{\lambda}\vec{e}_{\mu} = 0 \qquad \textbf{(1.12)}$$

In contrast, according to Kleinert, the topology-changing Diff(4)-violating "super-tetrads" beyond 1915 general relativity[9] obey (1.11) and also

$$\partial_{\lambda}\partial_{\nu}\vec{e}_{\mu} - \partial_{\nu}\partial_{\lambda}\vec{e}_{\mu} \neq 0 \qquad \textbf{(1.13)}$$

This anholonomic field is a third rank tensor field transforming homogeneously under holonomic global 1-1 diffeomorphisms that represent topology-preserving geometrodynamic gauge freedom in general relativity. However, this same anholonomic field transforms inhomogeneously as a connection field with respect to the local Lorentz group of base tangent vector fields at a fixed base point. The anholonomic part of the field[10] is then, according to James Corum

$$F_{\mu\nu}\left(\vec{r},t\right)_{anholonomic} = \Omega^{\lambda}_{\mu\nu} A_{\lambda} \qquad \textbf{(1.14)}$$

This breaks electromagnetic internal fiber U(1) gauge invariance[11]. It means that the electromagnetic 4-potential

$$\begin{aligned} A_{\lambda} &= \left(\vec{A}, -\phi\right) \\ A^{\lambda} &= \left(\vec{A}, \phi\right) \end{aligned} \qquad \textbf{(1.15)}$$

is a local observable 4-vector field. On the other hand, from the principle of minimal coupling, the kinetic mechanical 4-momentum P_{λ} is replaced by the gauge invariant combination[12]

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[8] There exist local inertial frames at a single point with vanishing Levi-Civita-Riemannian connection symbols.

[9] With torsion gaps in the tangent space for closed loops in the base space. Another way to look at this is to think of a Riemann surface with many sheets. Going around a closed loop in the base space is like going around a branch point, i.e. space-time defect, so you wind up in a different local tangent space, a different sheet of the Riemann surface corresponding to the parallel "universe next door" (R. A. Wilson) or a fold in the 3D membrane of M-theory (Jan and Aug, 2000 Scientific American). This corresponds to a traversable wormhole or "Star Gate" that explains much of the mystery of the UFO phenomenon.

[10] With base tangent vectors that have vorticity, i.e. *not* a "natural basis" in differential geometry.

[11] This is a classical analog to quantum spontaneous broken U(1) EM gauge symmetry in a superconductor.

[12] Note that the proper way to place the subscripts and superscripts when going from particle momenta to wave differential operators is counter-intuitive and can lead to formal inconsistencies if one is not careful.

$$\begin{aligned}
&P_\lambda \to P_\lambda - eA_\lambda \\
&P_\lambda \to \frac{\hbar}{i}\partial^\lambda \\
&P_\lambda = \left(\vec{p}, -E\right) \\
&P^\lambda = \left(\vec{p}, E\right) \\
&\partial_\lambda = \left(\vec{\nabla}, \frac{\partial}{\partial t}\right) \\
&\partial^\lambda = \left(\vec{\nabla}, -\frac{\partial}{\partial t}\right) \\
&\partial^\lambda \partial_\lambda = \vec{\nabla}^2 - \frac{\partial^2}{\partial t^2}
\end{aligned} \quad \textbf{(1.16)}$$

Therefore, if we make Corum's formula (1.14) U(1) gauge invariant

$$F_{\mu\nu}\left(\vec{r}, t\right)_{anholonomic} = -\Omega^\lambda_{\mu\nu}\left(\frac{1}{e}P_\lambda - A_\lambda\right) \quad \textbf{(1.17)}$$

and use

$$g_n = n\frac{2\pi}{e} \quad \textbf{(1.18)}$$

where g_n is the magnetic monopole charge for topological winding number n

$$F_{\mu\nu}\left(\vec{r}, t\right)_{anholonomic} = -\Omega^\lambda_{\mu\nu}\left(g_n P_\lambda - A_\lambda\right) \quad \textbf{(1.19)}$$

This gives the Blackett effect[13] for $n \geq 1$. That is, we have both a kinetic mechanical coupling and an electromagnetic coupling to the anholonomic field. On the other hand, when n = 0, the usual situation in the vacuum (1.19) is not classically gauge invariant since $g_n = 0$. Therefore, I have proved the theorem that the generation of an anholonomic field must change the normal topology in order to obey classical gauge invariance.

[13] Saul-Paul Sirag

The conventional wisdom is to choose χ such that

$$\begin{aligned}
&\vec{\nabla}\cdot\vec{A}+\frac{\partial\phi}{\partial t}=0\\
&\partial^{\lambda}A_{\lambda}=0\\
&\partial_{\lambda}=\left(\vec{\nabla},\frac{\partial}{\partial t}\right)\\
&\partial^{\lambda}=\left(\vec{\nabla},-\frac{\partial}{\partial t}\right)\\
&A_{\lambda}=\left(\vec{A},-\phi\right)
\end{aligned}\qquad\textbf{(1.20)}$$

this is called the *Lorentz condition*. Fourier analyze (1.20) into plane waves assuming flat space-time

$$k^{\lambda}\tilde{A}_{\lambda}\left(\vec{k},\omega\right)=0\qquad\textbf{(1.21)}$$

constrains the polarizations to only three independent polarizations corresponding to spin 1. The longitudinal polarization[14] along the propagation 3-vector $\vec{k}$ is proportional to the scalar (time-like) polarization. That is (1.21) is reexpressed as

$$\begin{aligned}
&\vec{k}\cdot\tilde{\vec{A}}-\omega\tilde{\phi}=0\\
&\left|\vec{k}\right|\tilde{A}_{longitudinal}=\omega\tilde{\phi}\\
&\tilde{A}_{longitudinal}\left(\vec{k},\omega\right)=\frac{\omega}{\left|\vec{k}\right|}\tilde{\phi}\left(\vec{k},\omega\right)
\end{aligned}\qquad\textbf{(1.22)}$$

Note, it is an error to assume the “mass shell” (light cone) condition

$$\left|\vec{k}\right|=\omega_{k}\qquad\textbf{(1.23)}$$

at this stage since we need to include virtual photons as well as real photons when we quantize the electromagnetic field. The non-radiating near fields of electrical equipment and inside our brains do not obey the mass shell condition (1.23). One can also imagine a generalized classical electrodynamics in which

$$\begin{aligned}
&\vec{\nabla}\cdot\vec{A}+\frac{\partial\phi}{\partial t}\neq 0\\
&\partial^{\lambda}A_{\lambda}\neq 0
\end{aligned}\qquad\textbf{(1.24)}$$

[14] Superluminal compression-rarification waves in the relativistic vacuum aether.

This is an analog to post-quantum “back-action” in configuration space in which

$$\vec{\nabla} \cdot \vec{j} + \frac{\partial \rho}{\partial t} \neq 0$$
$$\partial^{\lambda} J_{\lambda} \neq 0 \qquad \textbf{(1.25)}$$

We expect (1.24) as an expression of anholonomic constraint leakage or “slipping” from the seven unseen spatial dimensions of the universe according to M-theory. One can think of anholonomic constraints in classical mechanics as a clown riding on a unicycle pivoting without slipping on a rough surface. There are more degrees of freedom for the finite motion than for the infinitesimal motion.[15] (1.25) is similar for post-quantum entanglement in configuration space. (1.24) and (1.25) represent nonintegrable path-dependent anholonomic gauge constraints with multiply-connected field topologies compared to the simpler integrable holonomic gauge constraints of (1.20) to (1.22). The anholonomic gauge constraints still reduce the number of independent polarizations from 4 to 3 for the spin 1 vector fields. Further, if the local Lorentz frame invariant mass in the flat tangent space-time is zero, there are only two transverse polarizations that can be radiated into the far field. The longitudinal polarization is still there of course in the near field and is physically very important and dramatic as in the Tesla devices, electric motors and generators, circuit inductances and capacitors, brain waves etc.

Let us examine the classical electromagnetic Maxwell field equations in special relativistic notation in the case that gravity is negligible, but there is a strong coherent anholonomic field in the physical vacuum otherwise free of real ordinary material particles like electrons and protons on their mass shells. Therefore, for simplicity, I first assume that

$$J_{\mu(matter)} = 0 \qquad \textbf{(1.26)}$$

The vacuum divergence of the magnetic field and Faraday’s law of electromotive induction from changing magnetic flux are both contained in

$$\partial_{\alpha} F_{\beta\gamma} + \partial_{\beta} F_{\gamma\alpha} + \partial_{\gamma} F_{\alpha\beta} = 0 \qquad \textbf{(1.27)}$$

$$F_{\mu\nu} = \partial_{\mu} A_{\nu} - \partial_{\nu} A_{\mu} + \Omega^{\lambda}_{\mu\nu} A_{\lambda} \qquad \textbf{(1.28)}$$

$$\partial_{\sigma} F_{\mu\nu} = \partial_{\sigma}\partial_{\mu} A_{\nu} - \partial_{\sigma}\partial_{\nu} A_{\mu} + \partial_{\sigma}\Omega^{\lambda}_{\mu\nu} A_{\lambda} \qquad \textbf{(1.29)}$$

$$\Omega^{\lambda}_{\mu\nu} A_{\lambda} = -\Omega^{0}_{\mu\nu} A_{0} + \Omega^{1}_{\mu\nu} A_{1} + \Omega^{2}_{\mu\nu} A_{2} + \Omega^{3}_{\mu\nu} A_{3} \qquad \textbf{(1.30)}$$

[15] Arnold Sommerfeld’s “Mechanics”.

$$
\begin{aligned}
&\partial_1 F_{23} + \partial_2 F_{31} + \partial_3 F_{12} = 0 \\
&\vec{\nabla} \cdot \vec{B}_{holonomic} = \partial_1 B_1 + \partial_2 B_2 + \partial_3 B_3 = \\
&-\partial_1 \left(-\Omega^0_{23} A_0 + \Omega^1_{23} A_1 + \Omega^2_{23} A_2 + \Omega^3_{23} A_3 \right) \\
&-\partial_2 \left(-\Omega^0_{31} A_0 + \Omega^1_{31} A_1 + \Omega^2_{31} A_2 + \Omega^3_{31} A_3 \right) \\
&-\partial_3 \left(-\Omega^0_{12} A_0 + \Omega^1_{12} A_1 + \Omega^2_{12} A_2 + \Omega^3_{12} A_3 \right)
\end{aligned} \tag{1.31}
$$

That is, we have an anholonomic field vacuum with an effective magnetic monopole field distribution in which

$$
\begin{aligned}
&\vec{\nabla} \cdot \vec{B}_{anholonomic} \neq 0 \\
&\vec{\nabla} \cdot \vec{B}_{anholonomic} = \\
&\begin{bmatrix}
-\partial_1 \left(-\Omega^0_{23} A_0 + \Omega^1_{23} A_1 + \Omega^2_{23} A_2 + \Omega^3_{23} A_3 \right) \\
-\partial_2 \left(-\Omega^0_{31} A_0 + \Omega^1_{31} A_1 + \Omega^2_{31} A_2 + \Omega^3_{31} A_3 \right) \\
-\partial_3 \left(-\Omega^0_{12} A_0 + \Omega^1_{12} A_1 + \Omega^2_{12} A_2 + \Omega^3_{12} A_3 \right)
\end{bmatrix}_{vacuum}
\end{aligned} \tag{1.32}
$$

$$
\begin{aligned}
&\partial_0 F_{23} + \partial_2 F_{30} + \partial_3 F_{02} = 0 \\
&\partial_0 B_1 - \partial_2 E_3 + \partial_3 E_2 = \left[\partial_0 B_1 - \left(\vec{\nabla} \times \vec{E} \right)_1 \right]_{anholonomic} \\
&= \\
&\begin{bmatrix}
-\partial_0 \left(-\Omega^0_{23} A_0 + \Omega^1_{23} A_1 + \Omega^2_{23} A_2 + \Omega^3_{23} A_3 \right) \\
-\partial_2 \left(-\Omega^0_{30} A_0 + \Omega^1_{30} A_1 + \Omega^2_{30} A_2 + \Omega^3_{30} A_3 \right) \\
-\partial_3 \left(-\Omega^0_{02} A_0 + \Omega^1_{02} A_1 + \Omega^2_{02} A_2 + \Omega^3_{02} A_3 \right)
\end{bmatrix}_{vacuum}
\end{aligned} \tag{1.33}
$$

etc. for the remaining two spatial components of Faraday's induction law generalized to the anholonomic field. We see that an EMF can be induced in the anholonomic vacuum even if there is zero rate of change of the holonomic part of the magnetic flux through a wire loop placed in the vacuum. These are totally new hitherto unsuspected classical electromagnetic predictions in the presence of an anholonomic field generated from a nonsymmetric stress-energy tensor. The latter is thought to be impossible. However, I think that is an error.

Similarly, with the remaining two vacuum Maxwell field equations for Gauss's and Ampere's law with displacement current.

$$
\partial^\nu F_{\mu\nu} = J_{\mu(matter)} \to 0 \tag{1.34}
$$

The anholonomic version of Gauss's law for vacuum is precisely the equation that Bo Lehnert suggested semi-empirically to explain several anomalous experiments. We see that it is a trivial consequence of Corum's anholonomic field theory applied to Maxwellian electrodynamics in the classical vacuum. Gauss's law is from

$$\begin{aligned} &\partial^{\nu} F_{0\nu} = 0 \\ &\vec{\nabla}\cdot\vec{E}_{anholonomic} = -\partial^{\nu}\left(\Omega_{0\nu}^{\lambda} A_{\lambda}\right)_{vacuum} \end{aligned} \qquad \textbf{(1.35)}$$

Ampere's law is from the three "spatial"i = 1,2,3 equations

$$\begin{aligned} &\partial^{\nu} F_{i\nu} = 0 \\ &{}_{i=1,2,3} \\ &\left(\vec{\nabla}\times\vec{B}_{anholonomic} + \varepsilon_0 \frac{\partial\vec{E}}{\partial t}_{anholonomic}\right)_i = -\partial^{\nu}\left(\Omega_{i\nu}^{\lambda} A_{\lambda}\right)_{vacuum} \end{aligned} \qquad \textbf{(1.36)}$$

Next the Lorentz force[16] on an electrical charge *without radiation reaction*

$$\begin{aligned} &\vec{F} = \frac{d\vec{p}}{dt} = e\left(\vec{E} + \frac{d\vec{r}}{dt}\times\vec{B}\right) \\ &F_{\mu} = \frac{dP_{\mu}}{d\tau} = eF_{\mu\nu}\frac{dX^{\nu}}{d\tau} \\ &dt = \gamma d\tau \\ &\gamma = \frac{1}{\sqrt{1-\left(\frac{d\vec{r}}{dt}\right)^2}} \\ &F_{\mu} = e\left(\partial_{\mu}A_{\nu} - \partial_{\nu}A_{\mu} + \Omega_{\mu\nu}^{\lambda}A_{\lambda}\right)\frac{dX^{\nu}}{d\tau} \end{aligned} \qquad \textbf{(1.37)}$$

The "Ampere longitudinal force" term is in the anholonomic term $e\Omega_{\mu\nu}^{\lambda}A_{\lambda}\frac{dX^{\nu}}{d\tau}$ that J.P.Vigier and other French and Russian physicists are so keen on. Let us make this term gauge invariant from (1.19) and (1.18)

$$e\Omega_{\mu\nu}^{\lambda}\left(g_n P_{\lambda} - A_{\lambda}\right)\frac{dX^{\nu}}{d\tau} = \Omega_{\mu\nu}^{\lambda}\left(2\pi n P_{\lambda} - eA_{\lambda}\right)\frac{dX^{\nu}}{d\tau} \qquad \textbf{(1.38)}$$

[16] We will also need Schwinger's classical formula for Lorentz force on a magnetic monopole.

Consider the simplest possible case, not gauge invariant in which

$$\frac{dP_{\mu}}{d\tau} = 2\pi n \Omega^{\lambda}_{\mu\nu} P_{\lambda} \frac{dX^{\nu}}{d\tau} \tag{1.39}$$

$$\begin{aligned} \frac{d\left(m_0 \gamma\, dX_{\mu}/d\tau\right)}{d\tau} &\approx 2\pi n \Omega^{\lambda}_{\mu\nu} m_0 \gamma \frac{dX_{\lambda}}{d\tau}\frac{dX^{\nu}}{d\tau} \\ \frac{d\left(\gamma\, dX_{\mu}/d\tau\right)}{d\tau} &\approx 2\pi n \Omega^{\lambda}_{\mu\nu} \gamma \frac{dX_{\lambda}}{d\tau}\frac{dX^{\nu}}{d\tau} \end{aligned} \tag{1.40}$$

Note that the rest mass, and charges[17] of the test particle cancel out of this “tractor beam” anholonomic force quadratic in the 4-velocity of the test particle in the given local Lorentz frame.

I now use Corum’s *extension of Einstein’s equivalence principle* to work out a simple problem. Einstein showed that gravity fields for an observer in a Cartan moving frame at rest near a mass are *locally equivalent* to *translational accelerations* felt by an observer in a Cartan frame far from any mass. Similarly anholonomic fields are locally equivalent to rotations and torsions in a special kind of Cartan moving frame whose timelike direction, for an observer rotating in 3D space, traces out a worldline shaped like a *helix* with both curvature and torsion in 4D space-time. Corum writes:

“One may obtain a field of orthogonal frames by letting the helical world lines of the rotating observer provide the timelike direction and then construct orthogonal spatial vectors from the formulas of Frenet and Serret”

It is enough for actual classical macroscopic rotating machines we can build in the lab to go to the nonrelativistic limit

$$\frac{d^2 X_{\mu}}{dt^2} \approx 2\pi n \Omega^{\lambda}_{\mu\nu} \frac{dX_{\lambda}}{dt}\frac{dX^{\nu}}{dt} \tag{1.41}$$

For angular rotation ω about the z axis of cylindrical symmetry in 3D space, Corum[18] uses, for the locally equivalent helical Cartan frame, the one-forms ϖ^{a} dual to the local tangent space tetrad basis $\vec{e}_a$ also, of course, in that special local helical Cartan frame that is the analog to “Einstein’s elevator” in The Master’s gedankenexperiments. Perhaps, we should call this special Cartan moving frame “Corum’s centrifuge”? ☺

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[17] Both electric and magnetic.

[18] “Relativistic rotation and the anholonomic object”, J. Math. Phys, 18, April 1977, p. 770, J. F. Corum

$$\begin{aligned}
\varpi^1 &\approx dr \\
\varpi^2 &\approx d\varphi - \omega dt \\
\varpi^3 &\approx dz \\
\varpi^0 &\approx dt - r^2\omega d\varphi
\end{aligned} \tag{1.42}$$

$$\begin{aligned}
\vec{e}_1 &\approx \frac{\partial}{\partial r} \\
\vec{e}_2 &\approx \frac{\partial}{\partial \varphi} + r^2\omega\frac{\partial}{\partial t} \\
\vec{e}_3 &\approx \frac{\partial}{\partial z} \\
\vec{e}_0 &\approx \frac{\partial}{\partial t} + \omega\frac{\partial}{\partial \varphi}
\end{aligned} \tag{1.43}$$

$$\begin{aligned}
\Omega^2_{12} &= -\Omega^2_{21} \approx \frac{r\omega^2}{2} \\
\Omega^0_{12} &= -\Omega^0_{21} \approx r\omega \\
\Omega^0_{10} &= -\Omega^0_{01} \approx -\frac{r\omega^2}{2}
\end{aligned} \tag{1.44}$$

$$\begin{aligned}
&\frac{d^2X_1}{dt'^2} = \frac{d^2r'}{dt'^2} \\
&\approx 2\pi n\left(\Omega^2_{12}\frac{dX_2}{dt}\frac{dX^2}{dt} + \Omega^0_{12}\frac{dX_0}{dt}\frac{dX^2}{dt} + \Omega^0_{10}\frac{dX_0}{dt}\frac{dX^0}{dt}\right) \\
&= 2\pi n\left(\frac{r\omega^2}{2}\frac{dX_2}{dt}\frac{dX^2}{dt} - r\omega\frac{dX_0}{dt}\frac{dX^2}{dt} - \frac{r\omega^2}{2}\frac{dX_0}{dt}\frac{dX^0}{dt}\right) \\
&= 2\pi n\left(\frac{r\omega^2}{2}\left(\frac{(d\varphi - \omega dt)}{dt}\right)^2 - r\omega\frac{(dt - r^2\omega d\varphi)}{dt}\frac{(d\varphi - \omega dt)}{dt} - \frac{r\omega^2}{2}\left(\frac{(dt - r^2\omega d\varphi)}{dt}\right)^2\right) \\
&= 2\pi n\left(\frac{r\omega^2}{2}\left(\frac{d\varphi}{dt} - \omega\right)^2 - \left(r\omega - r^2\omega\frac{d\varphi}{dt}\right)\left(\frac{d\varphi}{dt} - \omega\right) - \frac{r\omega^2}{2}\left(1 - r^2\omega\frac{d\varphi}{dt}\right)^2\right) \\
&= 2\pi n\left(\frac{r\omega^2}{2}\left(\frac{d\varphi}{dt} - \omega\right)^2 - \left(r\omega - r^2\omega\frac{d\varphi}{dt}\right)\left(\frac{d\varphi}{dt} - \omega\right) - \frac{r\omega^2}{2}\left(1 - r^2\omega\frac{d\varphi}{dt}\right)^2\right)
\end{aligned} \tag{1.45}$$

Remember φ is the angular cylindrical coordinate of the test particle feeling the electromagnetic and anholonomic inertial force in the nonaccelerating inertial frame

AKA "LIF" of the tangent space of an event E to which it is momentarily coincident. The helical frame is related to this LIF by a Lorentz transformation h_α^μ. The anholonomic field transforms inhomogeneously, as a connection not a tensor, for this special group of transformations, i.e.

$$\Omega_{\beta\gamma}^{\alpha} = h_\lambda^\alpha h_\beta^\mu h_\gamma^\nu \Omega_{\mu\nu}^{\lambda} - h_\beta^\mu h_\gamma^\nu \frac{\partial h_\nu^\lambda}{\partial x^\mu} \tag{1.46}$$

This is in contrast to the global 1-1 topology-conserving Diff(4) group of *holonomic* integrable path-independent "general coordinate transformations"[19] $x^\mu \rightarrow x^{\mu'}$ of Einstein's 1915 theory relative to which the anholonomic field is a third rank tensor field, i.e.

$$\Omega_{\mu'\nu'}^{\lambda'} = \frac{\partial x^{\lambda'}}{\partial x^\lambda}\frac{\partial x^\mu}{\partial x^{\mu'}}\frac{\partial x^\nu}{\partial x^{\nu'}}\Omega_{\mu\nu}^{\lambda} \tag{1.47}$$

There has been considerable confusion on the physical distinctions here.

Let's take the very special case where the test particle is constrained to be at rest in the accelerating helical Cartan frame. Only in this case can we assume

$$\omega = \frac{d\varphi}{dt} \tag{1.48}$$

Many terms in (1.45) vanish, what we have left is

$$\frac{d^2 X_1}{dt'^2} \rightarrow \frac{d^2 r'}{dt'^2} = -\pi n r \omega^2 \left(1 - r^2\omega^2\right)^2 \tag{1.49}$$

Note, that the primes in r' and t' are the helical frame radial and time coordinates, but the unprimed r and t are in the LIF to which it is related by the local Lorentz transformation. *There is an anholonomic time distortion here beyond special relativity.* [20] This is also an effective attractive anholonomic gravity field in the *inward* radial direction because of the – sign that is oppositely directed to the radially outward centrifugal repulsive inertial force. This is a good sign for anholonomic warp drive in which the anholonomic field can be shaped to cancel g-forces so that the crew is on an effective timelike geodesic in free float. This property is shared by Alcubierre's solution. It may be that the antisymmetric anholonomic field added to the symmetric holonomic equations of general relativity will make such a warp drive practical.

[19] Diff(4) is to general relativity GR what U(1) electromagnetic internal gauge symmetry is to Maxwell's EM field theory. Both passive topology-conserving holonomic gauge symmetries are broken by active topology-changing anholonomic transformations.

[20] Perhaps explaining reports of sailors in "The Philadelphia Experiment" of 1943 that James Corum has been investigating . Corum disagrees with Jacques Vallee's "Anatomy of a Hoax" in Journal of Scientific Exploration.

Consider a rotating cylinder of charge. The repulsive potential energy is proportional to log r per unit length along the z axis. The outward centrifugal acceleration is $r\omega^2$, the repulsive electric field is proportional to $1/r$. We can balance the forces[21]

$$\frac{\kappa}{mr} + r\omega^2\left(1-\pi n\right) = 0 \tag{1.50}$$

$$\begin{aligned}
&\frac{\kappa}{m} + r^2\omega^2\left(1-\pi n\right) = 0 \\
&r^2\omega^2\left(1-\pi n\right) = -\frac{\kappa}{m} \\
&r^2 = -\frac{\kappa}{m\omega^2\left(1-\pi n\right)} \\
&r_n = \sqrt{-\frac{\kappa}{m\omega^2\left(1-\pi n\right)}} \\
&\omega r_n = \sqrt{-\frac{\kappa}{m\left(1-\pi n\right)}}
\end{aligned} \tag{1.51}$$

$$\begin{aligned}
&\frac{d^2X_2}{dt'^2} = \frac{d^2\varphi'}{dt'^2} = \frac{d^2\varphi}{dt^2} - \frac{d\omega}{dt} \\
&\approx 2\pi n\left(\Omega^2_{21}\frac{dX_2}{dt}\frac{dX^1}{dt} + \Omega^0_{21}\frac{dX_0}{dt}\frac{dX^1}{dt}\right) \\
&= 2\pi n\left(-\frac{r\omega^2}{2}\frac{dX_2}{dt}\frac{dX^1}{dt} + r\omega\frac{dX_0}{dt}\frac{dX^1}{dt}\right) \\
&= 2\pi n\left(-\frac{r\omega^2}{2}\left(\frac{d\varphi}{dt} - \omega\right)\frac{dr}{dt} + r\omega\left(1 - r^2\omega\frac{d\varphi}{dt}\right)\frac{dr}{dt}\right) \\
&= 2\pi n\frac{dr}{dt}\left(-\frac{r\omega^2}{2}\left(\frac{d\varphi}{dt} - \omega\right) + r\omega\left(1 - r^2\omega\frac{d\varphi}{dt}\right)\right)
\end{aligned} \tag{1.52}$$

$$\begin{aligned}
&\frac{d^2X_0}{dt'^2} \approx 2\pi n\Omega^0_{01}\frac{dX_0}{dt}\frac{dX^1}{dt} = \pi n r\omega^2\frac{dX_0}{dt}\frac{dX^1}{dt} \\
&\frac{d\left(1 - r^2\omega\frac{d\varphi}{dt}\right)}{dt} = \frac{-d\left(r^2\omega\frac{d\varphi}{dt}\right)}{dt} \approx \pi n r\omega^2\left(1 - r^2\omega\frac{d\varphi}{dt}\right)\frac{dr}{dt}
\end{aligned} \tag{1.53}$$

[21] The anholonomic field, with attraction cancelling electrical self-repulsion, may make it possible to make stable models of the extended classical electron "hidden variable" in Bohm's realistic quantum theory.

The canonical stress-energy tensor for the simplest spin 0 special relativistic classical scalar field ϕ with Lagrangian density L is

$$T^{\mu\nu} = -\frac{\partial L}{\partial\left(\partial_\nu \phi\right)}\partial^\mu \phi + \eta^{\mu\nu} L \quad \mathbf{(1.54)}$$

The first term on the RHS of (1.38) is not symmetric. The symmetry of the stress energy tensor for classical relativistic field theory is a completely ad hoc fudge factor based upon fundamentally incorrect physical ideas. I shall return to this thesis of course.