Mathematical Notes by Jack Sarfatti on the Physics of the Tic Tac Warp Drive Space Craft encountered by USS Nimitz Battle Group for two weeks November 2014[1]

March 17, 2019 V6

adastra1@icloud.com

under construction

One can start from the Einstein equations in the following form

$$R_{ik} = \frac{8\pi G}{c^4}\left(T_{ik} - \frac{1}{2} g_{ik} T\right). \qquad (1)$$

Just this form is convenient for an analysis of gravitational wave generation by a variable electromagnetic field so as the electromagnetic energy-momentum tensor of the field has a trace equal to zero ($T = 0$) and the equations (1) are reduced to

$$R_{ik} = \frac{8\pi G}{c^4} T_{ik}. \qquad (2)$$

In particular below we will be interested with spatial components of the gravitational wave. Then the energy-momentum tensor in (2) can be replaced by the Maxwell stress tensor:

$$T_{ik} \to T_{\alpha\beta} = -\sigma_{\alpha\beta}, \quad \alpha, \beta = 1,2,3.$$

$$\sigma_{\alpha\beta} = \frac{1}{4\pi}\left\{E_\alpha E_\beta + H_\alpha H_\beta - \frac{1}{2}\delta_{\alpha\beta}\left(\boldsymbol{E}^2 + \boldsymbol{H}^2\right)\right\}. \qquad (3)$$

The next simplification consists in transition to the weak gravitational field approximation

$$g_{ik} = \eta_{ik} + h_{ik}, \quad |h_{ik}| << 1$$

with the Lorentz gauge (or TT gauge [32])

$$\bar{h}^{ik}{}_{,k} = 0, \quad \bar{h}_{ik} = h_{ik} - \tfrac{1}{2}\eta_{ik} h,$$

Under this the Ricci tensor takes the form:

$$R_{ik} = \frac{1}{2}\Box h_{ik}.$$

Finally instead of (1) one comes to the equation

$$\Box h_{\alpha\beta} = -\frac{16\pi G}{c^4}\sigma_{\alpha\beta}. \qquad (4)$$

I recast the above Russian's equation to apply to the Tic Tac's[2] hull that I suspect to be made of an artificial an-isotropic pixelated multi-2D layered meta-material with lattices within lattices

---

[1] Gravitational Hertz experiment with electromagnetic radiation in a strong magnetic field
N I Kolosnitsyn1 and V N Rudenko2,3
1Smidt Earth Physics Institute RAS, kolosnitsynn@mail.ru, Moscow 119810, Russia,
2Institute of Nuclear Researches RAS, <valentin.rudenko@gmail.com>, Russia
3Sternberg Astronomical Institute MSU, Universitetskii pr. 13, Moscow 119234, Russia.

[2] https://nationalufocenter.com/2019/03/filers-files-10-2019-time-travelers/

(like Russian Dolls) from at least Angstrom scale to roughly micro-wave. The meta-material activates into weightless warp drive when resonantly pumped into the Frohlich active matter room temperature superconducting macro-quantum coherent state at required scales, frequencies and wave-vectors coordinated by a conscious AI super-intelligence.

I make the Ansatz, to be tested by its predicted consequences, that the coupling of matter to gravity in Einstein's GR field equation depends upon the actual local speed of light in the material – not the vacuum speed of light c. Precisely, introducing the inhomogeneous meta-material electrodynamic response function $\mathrm{Z}(x)$. [3]

$$\frac{G}{c^4} \to \frac{G}{c^4}\big(\varepsilon(x)\mu(x)\big)^2 = \frac{G}{c^4}\mathrm{Z}(x)$$

This is a local frame-invariant scalar tensor of rank zero obeying General Relativity's local coordinate covariance because

$$\varepsilon(x)\mu(x) = \varepsilon(x)_{\alpha\beta}\mu(x)^{\alpha\beta}$$

Is a zero rank tensor local frame invariant under the continuous coordinate transformations local symmetry group.[4]

For the electrical permittivity dielectric response function that is a second rank tensor in an anisotropic meta-material. Similarly, for the magnetic permeability. The metric warp field tensor is $g(x)_{\alpha\beta}$ and $g(x)^{\alpha\beta}$that is used to raise and lower tensor indices.

The Tic Tac's "engine" electrodynamic source field stress-energy tensor's 3D space-like slice eq. (3) that is the source term in the weak field wave equation (4) of the Russian paper above is recast as

---

https://www.youtube.com/channel/UCM1pWjIoLCxzj7sz6dk51gQ

https://www.youtube.com/watch?v=_KdkpS68Edk&fbclid=IwAR1cxYnqtUOZEij_0f9vTdQm0gSGU_xgGvVwdwMt_4VuKUVRpC-nHZ33nLw

[3] The vacuum speed of light c comes mainly from off-mass-shell virtual electron positron pair charge separations and magnetic motions inside the quantum vacuum. In the spirit, if not the letter, of Einstein's Equivalence Principle (EEP) both off-shell-virtual and on-shell real particles contribute to the matter-gravity coupling. This justifies my Ansatz to be tested by experiment. The key to the controlled weightless timelike geodesic low power warp drive motions (shape-shifting, apparent g-forces ~ 6,000 g etc.) are large resonances in $\mathrm{Z}(x)$.

[4] There is no problem with either of Noether's two theorems. https://arxiv.org/pdf/1601.03616.pdf

$$\sigma_{\alpha\beta} = \frac{1}{4\pi}\left\{\varepsilon_{\alpha\gamma}E^{\gamma}E_{\beta} + \mu_{\alpha\gamma}H^{\gamma}H_{\beta} - \frac{1}{2}\delta_{\alpha\beta}\left(g^{\tau\omega}\varepsilon_{\tau\gamma}E^{\gamma}E_{\omega} + g^{\tau\omega}\mu_{\tau\gamma}H^{\gamma}H_{\omega}\right)\right\}$$

Example 1. Quasi-Static Capacitor

Uniform electric field along the 3-axis e_3E where $\alpha, \beta = 1,2,3$ tangent vectors to the charged pixel plates order of 1 nanometer square in the 1,2 plane of local Cartesian frame of reference. The spacelike part of the EM source field's stress-energy tensor is therefore, the only non-vanishing electromagnetic symmetric tensor components sourcing the induced gravity field are

$$\sigma_{\alpha\beta} = \frac{1}{4\pi}\left\{\varepsilon_{\alpha 3}E^{3}E_{3}\delta_{\beta 3} - \frac{1}{2}\delta_{\alpha\beta}(g^{\tau 3}\varepsilon_{\tau 3}E^{3}E_{3})\right\}$$

Explicitly

$$\sigma_{11} = -\frac{1}{8\pi}g^{\tau 3}\varepsilon_{\tau 3}E^{3}E_{3}$$

$$\sigma_{12} = \sigma_{21} = 0$$

$$\sigma_{13} = \sigma_{31} = \frac{1}{4\pi}\varepsilon_{13}E^{3}E_{3}$$

$$\sigma_{22} = -\frac{1}{8\pi}g^{\tau 3}\varepsilon_{\tau 3}E^{3}E_{3}$$

$$\sigma_{12} = \sigma_{21} = 0$$

$$\sigma_{23} = \sigma_{32} = \frac{1}{4\pi}\varepsilon_{23}E^{3}E_{3}$$

$$\sigma_{33} = \frac{1}{4\pi}\left\{\varepsilon_{33}E^{3}E_{3} - \frac{1}{2}(g^{\tau 3}\varepsilon_{\tau 3}E^{3}E_{3})\right\}$$

Where

$$E^{3} = g^{3\gamma}E_{\gamma} \to g^{33}E_{3}$$

In the general warp geometrodynamical case of the Tic Tac, e.g. "dogfight" with Commander Fravor's F18 off the coast of San Diego on November 14, 2004 the gravitational field metric tensor and its anisotropic meta-material electromagnetic field "pump" ("fuel" power supply) stress tensor will be complicated controlled by a super-intelligence conscious AI post-quantum computer embedded in the smart skin fuselage itself – if my intuition proves correct. This is eminently Popper-falsifiable.

"In mathematics, the **convolution theorem** states that under suitable conditions the Fourier transform of a convolution of two signals is the pointwise product of their Fourier transforms. In other words, convolution in one domain (e.g., time domain) equals point-wise multiplication in the other domain (e.g., frequency domain). Versions of the convolution theorem are true for various Fourier-related transforms."[5]

If $\mathcal{F}$ denotes the Fourier transform operator, then $\mathcal{F}\{f\}$ and $\mathcal{F}\{g\}$ are the Fourier transforms of f and g, respectively. Then

$$\mathcal{F}\{f * g\} = \mathcal{F}\{f\} \cdot \mathcal{F}\{g\}$$

where $\cdot$ denotes point-wise multiplication. It also works the other way around:

$$\mathcal{F}\{f \cdot g\} = \mathcal{F}\{f\} * \mathcal{F}\{g\}$$

By applying the inverse Fourier transform $\mathcal{F}^{-1}$, we can write:

$$f * g = \mathcal{F}^{-1}\big\{\mathcal{F}\{f\} \cdot \mathcal{F}\{g\}\big\}$$

and:

$$f \cdot g = \mathcal{F}^{-1}\big\{\mathcal{F}\{f\} * \mathcal{F}\{g\}\big\}$$

The weak gravity field in the Minkowski flat background approximation Russian wave equation (4) in my Ansatz becomes

$$\left(\nabla^2 - \frac{\sqrt{Z}}{c^2}\frac{\partial}{\partial t}^2\right) h_{\alpha\beta} = -\frac{16\pi}{c^4} G Z \sigma_{\alpha\beta}$$

Consider the RHS driving source term. The scale-independent Fourier transforms are in symbolic (no indices) 4-vector notation

$$Z(x) \to \mathbb{Z}(k)$$

$$h(x)_{\alpha\beta} \to \eta(k)_{\alpha\beta}$$

Therefore, the 4-vector momentum space Fourier transform of the local space-time gravity field electromagnetic field source term is the 4D convolution multiple integral

$$-\frac{16\pi}{c^2} Z(x)\sigma(x)_{\alpha\beta} \to -\frac{16\pi}{c^2}\int \mathbb{Z}(k-q)\sigma(q)_{\alpha\beta}\, d^4q$$

The induced gravity warp field LHS of the Tic Tac is

$$\left(\nabla^2 - \frac{\sqrt{Z}}{c^2}\frac{\partial}{\partial t}^2\right) h_{\alpha\beta} \to \kappa^2 \eta(k)_{\alpha\beta} - \frac{\omega^2}{c^2}\int \sqrt{\mathbb{Z}(k-q)}\ \eta(q)_{\alpha\beta} d^4q$$

[5] https://en.wikipedia.org/wiki/Convolution_theorem

Where the 4-momentum vector is $k = (\kappa, \omega)$.

Einstein's GR gravity field equation for the inhomogeneous anisotropic dispersive meta-material hull is a nonlocal integral equation in 4-momentum space in this background-dependent weak gravity field approximation.

Far-field on-mass-shell induced gravity waves of frequency ω and 3-wave vector κ with two independent spin 2 transverse polarizations must obey the pole of the Green's function integral equation condition

$$\kappa^2 \eta(k)_{\alpha\beta} - \frac{\omega^2}{c^2} \int \sqrt{\mathbb{Z}(k-q)}\ \eta(q)_{\alpha\beta} d^4 q = 0$$

The much more important non-radiative "Tesla" off-mass-shell gravity near fields with additional non-transverse polarizations violate the above constraint. Indeed we are interested in the quasi-static limit where frequency ω approaches zero, i.e.

$$\omega \ll c\kappa$$

The Green's function scalar Fourier transform is non-rigorously symbolically

$$\Gamma(k-q) = \frac{1}{\kappa^2 - \frac{\omega^2}{c^2} \int \sqrt{\mathbb{Z}(k-q)}}$$

In the sense that

$$\eta(k)_{\alpha\beta} = -\frac{16\pi}{c^2} \int \Gamma(k-q)\, d^4 q \int \mathbb{Z}(q-q')\sigma(q')_{\alpha\beta}\, d^4 q'$$

Moving forward, in analogy with the mean-field approximation in the Hartree-Fock approximation in the many-electron problem, I make the very crude approximation for the Green's function ($\mp i\epsilon$ contours in complex energy plane left unspecified for now)

$$\Gamma(\kappa, \omega) \to \frac{1}{\kappa^2 - \frac{\omega^2 \varepsilon(\kappa,\omega)\mu(\kappa,\omega)}{c^2}}$$

$$\eta(k)_{\alpha\beta} = -\frac{16\pi}{c^4} G \int \frac{1}{(\langle k\rangle - \langle q\rangle)^2 - \frac{(\omega - f)^2 \varepsilon_{\mu\upsilon}(k-q)\mu^{\mu\upsilon}(k-q)}{c^2}} d^4 q \int (\varepsilon(q-q')\mu(q-q'))^2 \sigma(q')_{\alpha\beta}\, d^4 q'$$

Note that this expression is a generally coordinate covariant tensor equation. The pole denominator in the Green's function is the scalar invariant inner product of two 4-vectors. The modified speed of light c' in matter is still a tensor of zero rank (i.e. a local frame invariant).[6]

$$c'^2 = \frac{c^2}{\varepsilon_{\mu\upsilon}\mu^{\mu\upsilon}}$$

Where the spacelike 3-vector pieces of the 4-vectors are enclosed in angular brackets[7]

However, the Fourier transform is not adequate for the metric engineering of the Tic Tac low power warp drive that is inhomogeneous in space and well as in time. We need time-frequency analysis generalized to 4D space-time's "phase space."[i]

Wigner's phase space transform[8]

$$\tilde{F}\left(x^\mu, k^\mu\right) = \int F\left(x^\mu - y^\mu, x^\mu + y^\mu\right) e^{i g_{\lambda\gamma} k^\lambda y^\gamma} d^4 y$$

We need a convolution theorem for the Wigner transform of a product of functions.

$$\tilde{F}\left(x^\mu, k^\mu\right) \otimes \tilde{\mathrm{K}}\left(x^\mu, k^\mu\right) = \int \tilde{F}\left(x^\mu - z^\mu, k^\mu - \kappa^\mu\right) \tilde{\mathrm{K}}\left(z^\mu, \kappa^\mu\right) d^4 z d^4 \kappa$$

For a more accurate analysis

Wavelets and renormalization group in quantum field theory problems

M.V. Altaisky

(Submitted on 14 Dec 2017)

Using continuous wavelet transform it is possible to construct a regularization procedure for scale-dependent quantum field theory models, which is complementary to functional renormalization group method in the sense that it sums up the fluctuations of larger scales in order to get the effective action at small observation scale (M.V.Altaisky, Phys. Rev. D93(2016) 105043.[9]

---

[6] The Greek symbol mu is used both as the magnetic permeability and a tensor index. However, the context should be clear. Will fix this at a later date.

[7] $\langle k \rangle = \kappa \;\; , k = (\langle k \rangle, \omega) \; q = (\langle q \rangle, f)$

[8] https://en.wikipedia.org/wiki/Wigner_distribution_function more generally we will need Mikhail Altaisky's scale-dependent wavelet transforms.

[9] https://arxiv.org/abs/1712.05402 and similar papers by the same author on https://arxiv.org/find/all/1/

Appendix 1

Notes on Richard C. Tolman's "Relativity, Thermodynamics and Cosmology"

$$D_\alpha = \varepsilon_{\alpha\beta} E^\beta$$
$$B_\alpha = \mu_{\alpha\beta} H^\beta$$
$$J_\alpha = \sigma_{\alpha\beta} E^\beta$$
$$\alpha, \beta = x, y, z \qquad (1.1)$$

In the rest frame of a small chunk of electromagnetically anisotropic matter in a Local Inertial Frame (LIF).

e.g. layered meta-materials with graphene and/or quantum dot networks et-al 2D sheets.

"Small" relative to radii of space-time curvature.

$$F^{\mu\nu} = \begin{matrix} 0 & B_z & -B_y & -E_x \\ -B_z & 0 & B_x & -E_y \\ B_y & -B_x & 0 & -E_z \\ E_x & E_y & E_z & 0 \end{matrix}$$

$$H^{\mu\nu} = \begin{matrix} 0 & H_z & -H_y & -D_x \\ -H_z & 0 & H_x & -D_y \\ H_y & -H_x & 0 & -D_z \\ D_x & D_y & D_z & 0 \end{matrix} \qquad (1.2)$$

$\mu, \nu = t, x, y, z$

$$J^\mu = \left(\rho, \frac{J^\alpha}{c} \right)$$
$$c = \sqrt{\frac{1}{\varepsilon_{\mu'\nu'} \mu^{\mu'\nu'}}} \qquad (1.3)$$

$$x^1 = x, x^2 = y, x^3 = z, x^4 = ct$$
$$ds^2 = -\left(dx^1\right)^2 - \left(dx^2\right)^2 - \left(dx^3\right)^2 + \left(dx^4\right)^2 \qquad (1.4)$$

Maxwell's electrodynamic field equations in the material local inertial rest frame are

$$\frac{\partial F_{\mu\nu}}{\partial x^{\sigma}}+\frac{\partial F_{\nu\sigma}}{\partial x^{\mu}}+\frac{\partial F_{\sigma\mu}}{\partial x^{\nu}}=0$$

Faraday's law of induction & no magnetic monopoles

$$dF=0$$

Cartan's exterior differential forms

$$\frac{\partial H^{\mu\nu}}{\partial x^{\nu}}=J^{\mu} \tag{1.5}$$

Ampere's law & Gauss's law

$$d*F=J$$

$$*F=H$$

*=Hodge dual

$$J^{\mu}-J_{\sigma}\frac{dx^{\sigma}}{ds}\frac{dx^{\mu}}{ds}=\sigma^{\mu}_{\lambda}\sqrt{\varepsilon_{\mu'\nu'}\mu^{\mu'\nu'}}g_{\gamma\delta}F^{\delta\lambda}\frac{dx^{\gamma}}{ds}$$ (1.6)[10]

Linearized Einstein weak gravity field wave equation[11]

$$\left(-\frac{\partial^2}{\partial x^2}-\frac{\partial^2}{\partial y^2}-\frac{\partial^2}{\partial z^2}+\varepsilon_{\mu'\nu'}\mu^{\mu'\nu'}\frac{\partial^2}{\partial t^2}\right)\left(h_{\mu\nu}-\frac{1}{2}\delta_{\mu\nu}h^{\lambda}_{\lambda}\right)=-16\pi G\left(\varepsilon_{\mu'\nu'}\mu^{\mu'\nu'}\right)^2 T_{\mu\nu}$$

$$g_{\mu\nu}=\eta_{\mu\nu}+h_{\mu\nu} \tag{1.7}$$

$$\eta_{\mu\nu}=\begin{matrix}-1 & 0 & 0 & 0\\ 0 & -1 & 0 & 0\\ 0 & 0 & -1 & 0\\ 0 & 0 & 0 & 1\end{matrix}$$

General formal Green's function solution is

$$\left(h_{\mu\nu}(x)-\frac{1}{2}\delta_{\mu\nu}h^{\lambda}_{\lambda}(x)\right)=-4G\int\Gamma(x,x')\left(\varepsilon_{\mu'\nu'}(x')\mu^{\mu'\nu'}(x')\right)^2 T_{\mu\nu}(x')d^4x' \tag{1.8}$$

We eventually want to do something like a Wigner phase-space density transform in which we capture, at least approximately, both wave 4-frequency and space-time location and resolution scale. We are primarily interested in the non-radiative quasi-static inhomogeneous near field solutions relevant to low power metric engineering "warp drive."

---

[10] Eq. 51.3 p.104, Tolman generalized by me to electromagnetic anisotropic matter.

[11] Eq. 93.7 p.237

[i] “In signal processing, **time–frequency analysis** comprises those techniques that study a signal in both the time and frequency domains *simultaneously,* using various time–frequency representations. Rather than viewing a 1-dimensional signal (a function, real or complex-valued, whose domain is the real line) and some transform (another function whose domain is the real line, obtained from the original via some transform), time–frequency analysis studies a two-dimensional signal – a function whose domain is the two-dimensional real plane, obtained from the signal via a time–frequency transform.[1][2]

The mathematical motivation for this study is that functions and their transform representation are often tightly connected, and they can be understood better by studying them jointly, as a two-dimensional object, rather than separately. …

The practical motivation for time–frequency analysis is that classical Fourier analysis assumes that signals are infinite in time or periodic, while many signals in practice are of short duration, and change substantially over their duration. For example, traditional musical instruments do not produce infinite duration sinusoids, but instead begin with an attack, then gradually decay. This is poorly represented by traditional methods, which motivates time–frequency analysis.

One of the most basic forms of time–frequency analysis is the short-time Fourier transform (STFT), but more sophisticated techniques have been developed, notably wavelets. …

History[edit]

See also: History of wavelets

Early work in time–frequency analysis can be seen in the Haar wavelets (1909) of Alfréd Haar, though these were not significantly applied to signal processing. More substantial work was undertaken by Dennis Gabor, such as Gabor atoms (1947), an early form of wavelets, and the Gabor transform, a modified short-time Fourier transform. The Wigner–Ville distribution (Ville 1948, in a signal processing context) was another foundational step.

Particularly in the 1930s and 1940s, early time–frequency analysis developed in concert with quantum mechanics (Wigner developed the Wigner–Ville distribution in 1932 in quantum mechanics, and Gabor was influenced by quantum mechanics – see Gabor atom); this is reflected in the shared mathematics of the position-momentum plane and the time–frequency plane – as in the Heisenberg uncertainty principle (quantum mechanics) and the Gabor limit (time–frequency analysis), ultimately both reflecting a symplectic structure.

An early practical motivation for time–frequency analysis was the development of radar – see ambiguity function.”

https://en.wikipedia.org/wiki/Time–frequency_analysis