Lectures in UFO/UAP Metric Engineering Physics

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Introduction

There is a subtle mathematical inconsistency in Einstein's 1916 General Relativity gravitational field equation inside matter that has never been noticed before because it makes only small errors when applied to corrections inside matter in most applications but not all. It does not affect GPS for example. However, it may affect some stellar, white dwarf, neutron star equations of state calculations. The only reason I noticed it is because agents of the CIA and DOD asked me to explain "flying saucer" propulsion more than 50 years ago. [2]The Pentagon disclosure in the New York Times in December 2017 in the article by Leslie Kean et-al spurred me on to rethink the problem. I already had the key idea in my invited talk to the DARPA-NASA 100 Year Starship Meeting in Orlando, Florida in October 2011.[3] However, collaborative work in 2020 with Professor Keith Wanser, Physics Department, Cal State Fullerton, made me realize this mathematical inconsistency which I will now explain.

Einstein's field equation inside matter is normally thought to be a set of coupled nonlinear partial differential equations[4] that are local in space-time.

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[1] https://vixra.org/pdf/2206.0073v1.pdf
https://vixra.org/abs/2206.0074

[2] "How the Hippies Saved Physics" MIT physics professor David Kaiser (2011) on my CIA/DOD connections in the 1970s.

[3] https://www.bbc.com/future/article/20120321-searching-for-a-starship Sharon Weinberger

[4] With propagating gravity far field hyperbolic PDEs and confined near gravity field elliptical PDE constraints. Earth's surface gravity is the latter. Far field gravity waves are normally hard to detect as shown by LIGO's detections from black hole, spinning neutron stars et-al after 100 years since Einstein predicted them. https://www.ligo.caltech.edu/page/gw-sources

$$G_{\mu\nu}(X) = 8\pi\left(\frac{G}{c^4}\right)T_{\mu\nu}(X)$$

$G_{\mu\nu}(X)$ is the *output* induced gravity curvature warp tensor field. $T_{\mu\nu}(X)$ is the *input* stress-energy density source tensor field.

The conventional wisdom of The Pundits that I think is mistaken is that from Maxwell's 1860's classical electromagnetic field theory[5] that the "c" inside matter is the coordinate vacuum speed of light of 186,000 miles per second

$$\frac{1}{c^2} = \varepsilon_0\mu_0$$

Where ε_0 is the electric vacuum permittivity and μ_0 is the magnetic vacuum permeability. There are several conceptual errors here in the conventional wisdom group think.

1) It is argued that the vacuum speed of light is the same all over the universe and in every direction. This is global homogeneity and isotropy of the vacuum speed of light. We now know from quantum field theory that this may not even be true because the actual values of the vacuum permittivity and vacuum permeability are *contingent* on the dynamics of real photon scattering off virtual charged particle Zero Point Fluctuations (ZPF). [i]The dominant process is from virtual electron-positron pairs of negative ZPF energy with a positive ZPF pressure that is three times stronger working in opposition to the ZPF energy, therefore, itself inducing a "dark matter" attractive gravity field. On the other hand, virtual bosons, charged and neutral, have negative pressure and induce a "dark energy" repulsive anti-gravity field. If the quantum vacuum is gravity neutral, then the densities of virtual fermion-antifermion pairs and virtual bosons must balance. There is also the Bondi effect in which a positive active gravity mass near a negative active gravity mass will self-accelerate in what is actually a timelike geodesic precursor to the Alcubierre warp drive, which what the US Navy has seen in the Close Encounters of their pilots David Fravor, Ryan Graves, and others.
2) What really matters is the frame invariance of Einstein's tensor field equations. The idea of a "tensor"[ii] in Einstein's two theories of relativity special 1905 and general 1915 is contingent on the mathematical group of physically well-defined frame of reference transformations of a pair of observers Alice and Bob using retarded far field electromagnetic waves propagating in vacuum both measuring the same event X independent of the contingent choice of local coordinates each of them elect to use for their measurement data. More precisely, the future vacuum light cone at X must intersect the past light cones of Alice and Bob's detector measurement events $X(A)$ *and* $X(B)$. [iii] Einstein's 1905 global special relativity only deals with a restricted class of tensors of the 6-parameter Lorentz subgroup (aka, 4D space-time rotations) of **inertial frame transformations**. Einstein's gravitational field comes from the local gauging of the global 4-parameter space-time translation group down to a local group in which the Levi-Civita connection gauge potentials for parallel transport of tensor fields emerges.[iv]

[5] Maxwell unified electricity, magnetism, and light back in the middle of the 19th Century.

Wednesday, June 1, 2022
London UK

Behind it all is surely an idea so simple, so beautiful, that when we grasp it - in a decade, a century, or a millennium - we will all say to each other, how could it have been otherwise? How could we have been so stupid?

John Archibald Wheeler

Motivation

US Navy Close Encounters with UAPs[6] now declassified can only be explained as warp drive i.e., control of the gravity field inside the fuselage of the craft with small amount of power wattage.[v]

This means that the coupling of source stress-energy current densities to gravity in Einstein's 1916 gravity field equation is controllable. Hitherto this was thought to be impossible. That belief is now Popper falsified by the observational facts released by US DOD/IC now being investigated by Congress as an imminent military threat.

The formula for the coupling given by Einstein is G/c^4 where G is Newton's constant and c is thought to be the speed of light waves in vacuum.

The theoretical justification for this belief is almost non-existent. It is essentially an article of faith that Einstein derived from a dimensional analysis to get agreement with Newton's static Poisson equation for gravity in the weak field limit of Einstein's General Relativity.

This was in 1916 before quantum theory and before any real understanding of the small-scale structure of materials. In fact, almost all textbooks on general relativity simply set $G/c^4 = 1$ in a Rube Goldberg contrived set of physical units and proceed to forget about it in their mathematical investigations. Indeed, Einstein's gravity field equation in vacuum is simply

$$G_{uv} = 0$$

In which the coupling G/c^4 does not appear explicitly at all since there is no source matter. It does appear implicitly in the spherical vacuum solutions as in

$$g_{00} = 1 - 2GE/c^4 r$$

6 https://www.mdpi.com/2504-3900/33/1/26

where E is the total energy of the source and r is the radial distance from the center of E OUTSIDE the boundary of E.

The physics of materials is complicated by refraction and dispersion in which the effective speed of light c can depend on frequency, wavelength, and even other material parameters. One must distinguish, phase speed, from group speed, from wave front signal speed inside matter. This does not happen in vacuum of course. Also, we need to distinguish far field radiation from real photons from near field virtual photons in quantum electrodynamics (aka evanescent waves) So what "c" are we even talking about in Einstein's equation inside matter? which is

$$G_{uv} = 8\pi(G/c^4)T_{uv}$$

Where T_{uv} is the source stress energy tensor and G_{uv} is the induced gravity field tensor.

Now pure mathematics of tensor calculus comes to the rescue. It tells us that the coupling, let's call it k must be a scalar because both G_{uv} and T_{uv} are tensors.

Now we come to the final nail in the coffin of the unjustified belief that c is the phase speed of light in vacuum in Einstein's field equation inside matter.

c is not a scalar as required by the mathematics as well as the physical meaning of relativity in terms of transformations among different frames of reference of observer-detectors all measuring the same external processes using far field electromagnetic waves moving through vacuum – not even air where corrections need to be made.

We will now go into a deeper discussion of what tensors and scalars are in terms of these physical frame transformations, but the key point is that Einstein's field equation inside matter as written in all the textbooks is not mathematically consistent if one uses the phase speed of light in vacuum as part of the coupling k inside matter.

Theoretical physics is based upon objective reality whose mathematical expression is that of invariants under symmetry groups of different kinds of transformations of frames of reference of different observers using detectors of electromagnetic signals that remotely sense external processes for far field signals and that locally measure processes for near field evanescent signals.

Examples of the former are in Einstein's original 1905 papers on special relativity where he gives thought experiments for time dilation and length contraction of objects in motion relative to the observer's detectors using far field signals consisting of real photons in a macro-quantum coherent state. An example of the latter is when you weigh yourself standing on a scale. You are measuring your actual local proper tensor acceleration radially outward from center of Earth (approximated idealized as a perfect uniform sphere of homogenous isotropic matter). You are not moving relative to Earth because the Earth has curved the spacetime you are in. The scale exerts an evanescent near electric field of virtual photons in a macro-quantum coherent state on you and if it was removed along with the part of Earth it rests on in a hollow tube through the center of Earth to the opposite side, you would fall freely weightless on a time like geodesic in the variable curvature of spacetime inside the hollow tube and you would oscillate in a simple harmonic motion from one end of the hollow tube to the other. You can imagine Elon Musk making this hyper tube connecting the antipodes.

The vacuum phase speed of light c is a scalar invariant only in 1905 Special Relativity under the restricted Lorentz group of transformations between weightless inertial observers Alice and Bob each moving uniformly on "geodesics" without acceleration and rotation through vacuum in globally flat spacetime, i.e., no real gravity fields as understood in the later 1916 General Relativity. Laboratories here on Earth are not inertial frames but are non-inertial frames. We ignore this discrepancy to a good approximation for many practical purposes but not for others such as our GPS system that must use the corrections from General Relativity.

General Relativity is concerned with transformations between observers Ted and Carol who are each moving on arbitrary accelerating slower than vacuum speed of light paths, called "non-geodesics." Unlike inertial weightless Alice and Bob who do not feel G-forces (aka "weight"), non-inertial Ted and Carol do feel G-Force from the electromagnetic force acting on their electric charges pushing them off the zero G-force timelike subluminal geodesic world lines in the 4D curved spacetime that is the real gravity field as explained by Einstein in 1916. General Relativity also includes transformations between inertial Alice and non-inertial Ted as well as those between inertial Alice and inertial Bob.

Now, what the US Navy is reporting is Close Encounters with vehicles that are moving on zero G-Force geodesics that the vehicles are themselves controlling with small amounts of electromagnetic power (Watts). The occupants inside these "warp drive" vehicles are weightless even though to outside observers like US Navy pilots David Fravor and Ryan Graves, it looks like impossibly high g-forces are there that would rip the vehicles apart if they were moving through space with conventional propulsion rather than manipulating spacetime itself. Of this there is no doubt because the physical explanation in terms of Einstein's battle-tested General Relativity is obvious to any competent physicist in the field who accepts the US Navy reports as true facts of observation. There is no alternative correct explanation in terms of mainstream physics.

This then demands a modification of Einstein's equation inside matter from

$$G_{uv} = 8\pi(G/c^4)T_{uv}$$

Which is mathematically incorrect because G/c^4 is not locally frame invariant under the full symmetry group of General Relativity to

$$G_{uv} = 8\pi(GS/c^4)T_{uv}$$

In which S is a new field that corrects the non-invariance of "c" under all the General relativity frame transformations.[vi]

Summary

Both c and S are separately invariant under the smaller Lorentz group of inertial frame transformations, but neither are separately invariant under the larger group of non-inertial frame transformations.

However, the combined product GS/c^4 is invariant under all the transformations required by General Relativity.

We shall see there are quantum reasons for this as well coming from Hawking's discovery that black holes evaporate.

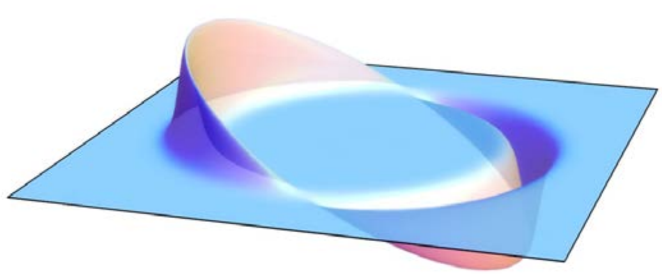
Low power warp drive is simple conceptually. Given a *fixed* desired gravity warp field tensor G_{uv} a resonance in S, i.e., S >> 1 means a smaller stress-energy tensor T_{uv} is needed to accomplish the mission.

Now exactly what S is made from in terms of the electromagnetic properties of meta-materials is the problem we have not yet solved, but whoever is flying those machines in US Navy battle space has solved.

The Warp Drive Metrics of Alcubierre, Natario et-al Contain an Error about FTL

Alcubierre Drive

- Solution to Einstein's field equations for warp speed travel
- Requires a lot of negative energy density
- Biggest challenge is not the just negative energy density
- **The challenge is getting a large quantity of negative energy**



Courtesy: Wikipedia

The warp drive metrics ask the wrong question. They describe what distant observers outside the warp bubble see. The relevant question is what is happening inside the warp bubble. To make a crude analogy. The exterior Schwarzschild vacuum metric for static LNIF detectors is

$$g_{00} = 1 - \frac{2GM}{c^2 r}$$

In contrast the interior metric for a homogeneous isotropic sphere of mass density ρ is

$$g_{00}^{int} = 1 - \frac{4\pi G\sqrt{S}}{3c^2}\rho r^2$$

The key idea is that "**A**lice" **I**ntelligence inside her 30 foot diameter, 3500 lb. Roswell Flying Saucer[7] controls her local timelike zero G force weightless geodesic along with her local light cone that tilts relative to the field of light cones of the distant external observers.

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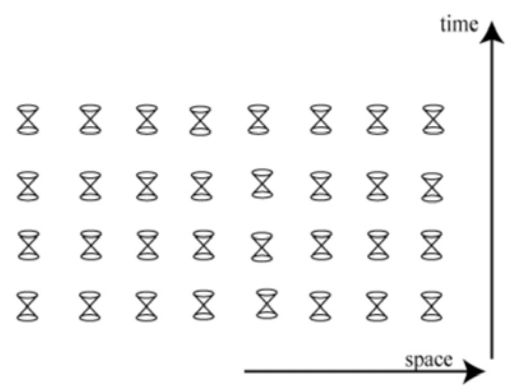
[7] "The Day After Roswell" Colonel Philip J. Corso,
Captain Richard J. Doty https://www.youtube.com/watch?v=4sn8Z6uuF1E

Stanford Encyclopedia of Philosophy

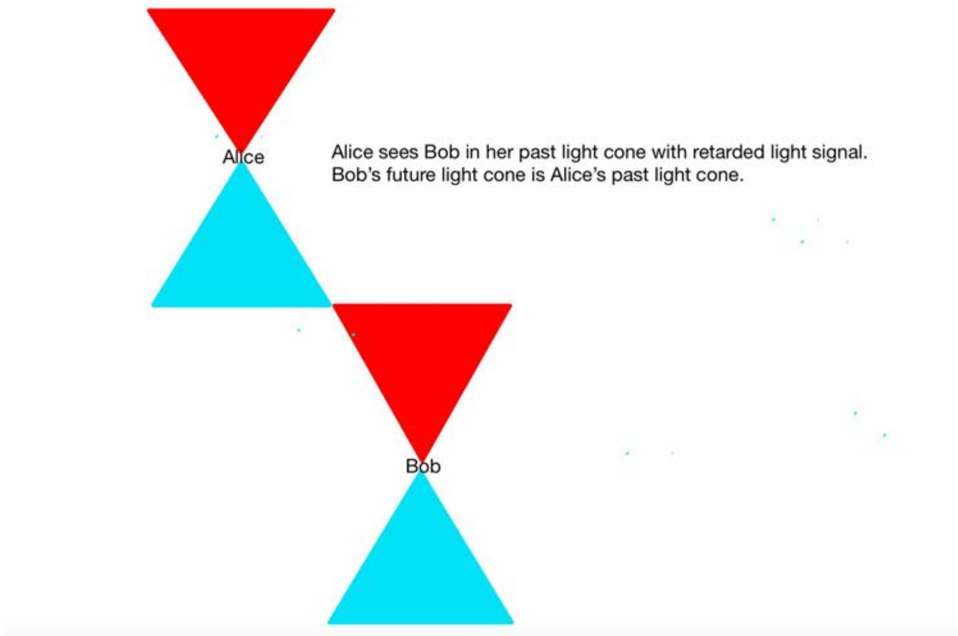
- Light Cones and Causal Structure
- In attempting to diagram relativistic spacetimes, one of the most important features to capture is the *causal structure* of the spacetime. This structure specifies which events (that is, which points of space and time) can be connected by trajectories that are slower than light, which events can be connected by trajectories traveling *at* the speed of light, and which events cannot be connected by anything traveling at or below light speed. Events in the first group are said to be "timelike related", because a physical clock could travel from one event to the other. Events in the second group are "lightlike related" because a light ray can travel from one to the other. Events in the third group are "spacelike related". Given that it is physically impossible (on the standard interpretation of relativity theory) for any causal process to exceed the speed of light, these three possible ways of being connected tell us whether one event is able to influence another.

https://plato.stanford.edu/entries/spacetime-singularities/lightcone.html

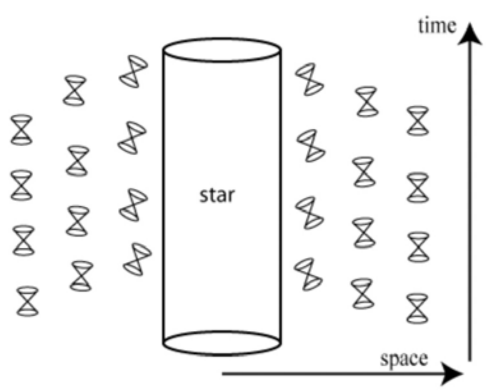
We depict flat spacetime by keeping all the light cones oriented in the same direction, as in the following figure.



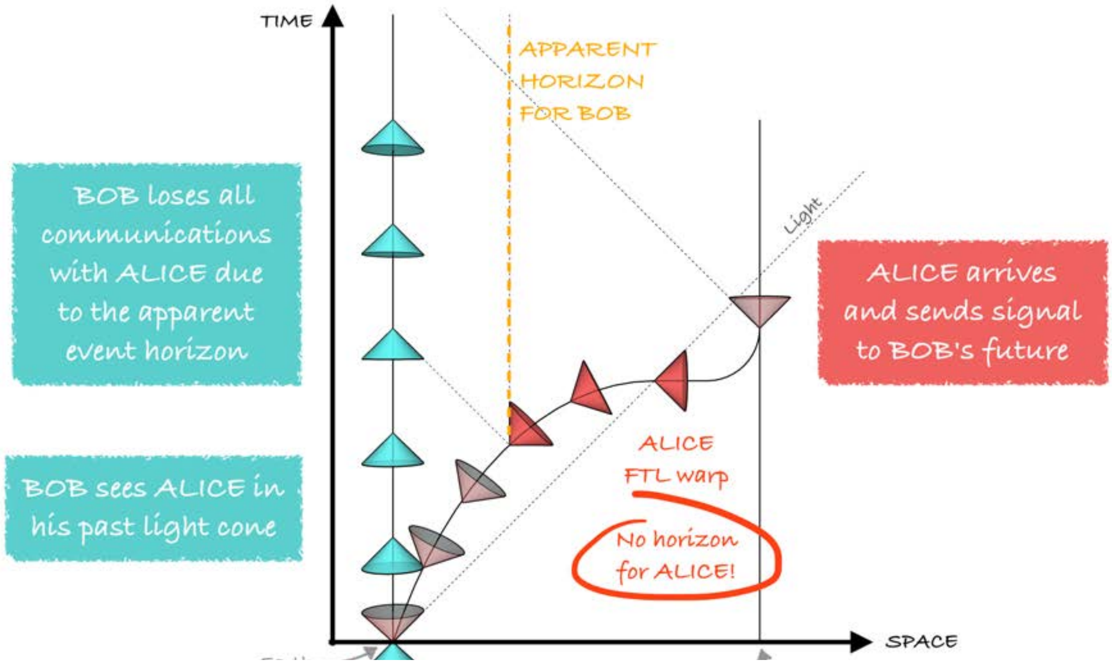
https://plato.stanford.edu/entries/spacetime-singularities/lightcone.html

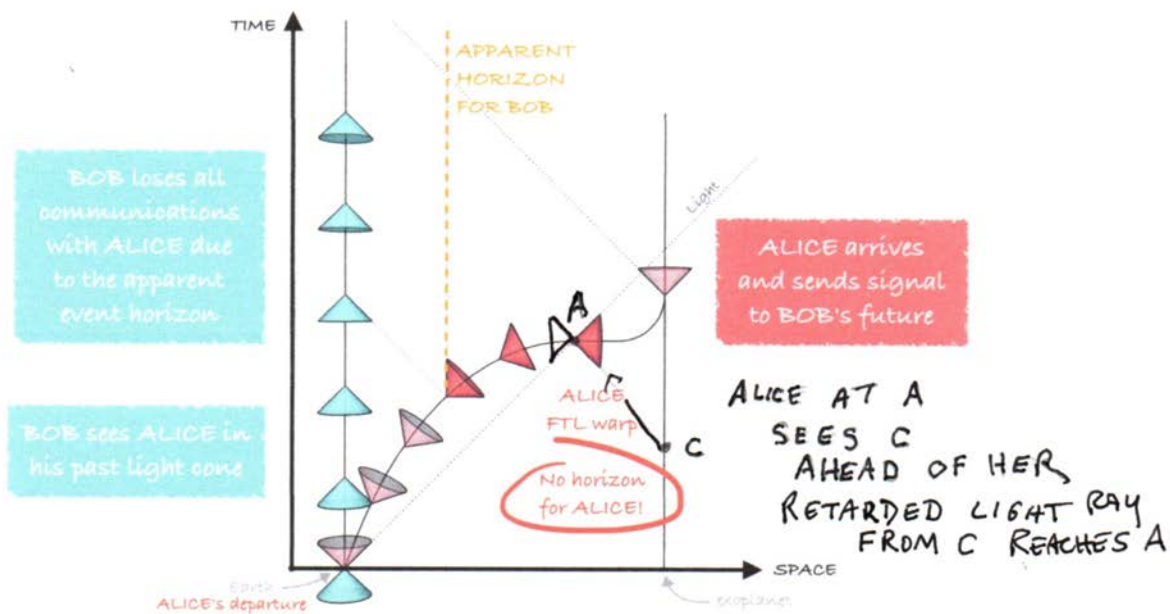


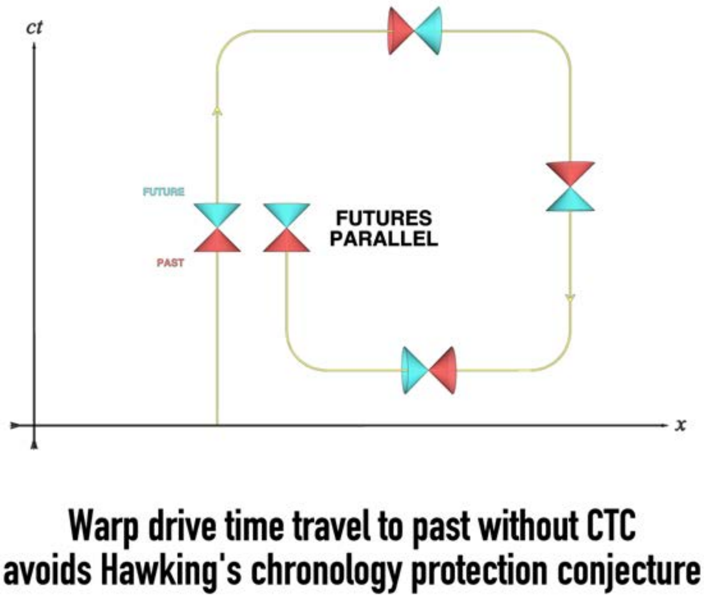
The curvature of spacetime, then, will be depicted by the tilting of these light cones. This reflects the fact that the causal structure of such spacetimes is different from that of flat spacetimes. So, for example, the spacetime around a massive body like a star will be depicted as follows.



We have a black hole when the curvature of spacetime becomes so severe that, for some region, there is no path *out* of that region that remains inside its own light cones. That is, the causal structure of the spacetime is such that one cannot escape from that region without traveling faster than light. Such a region is by definition a black hole; the border of that region is the event horizon.


TIME
APPARENT
HORIZON
FOR BOB
BOB loses all communications with ALICE due to the apparent event horizon
Light
ALICE arrives and sends signal to BOB's future
ALICE
FTL warp
BOB sees ALICE in his past light cone
No horizon for ALICE!
SPACE


TIME
APPARENT
HORIZON
FOR BOB
BOB loses all communications with ALICE due to the apparent event horizon
Light
ALICE arrives and sends signal to BOB's future
A
ALICE
FTL warp
C
BOB sees ALICE in his past light cone
No horizon for ALICE!
SPACE
ALICE's departure
ALICE AT A
SEES C
AHEAD OF HER,
RETARDED LIGHT RAY
FROM C REACHES A



Mathematics

The coordinate speed of light is invariant under Special Relativity's Lorentz Group of inertial frame transformations.

We can use a single space-dimension to simplify the math without losing the key idea.

The differential space-time invariant is

$$ds^2 = c^2dt^2 - dx^2$$

Einstein used the geometric optics limit of light rays in which the diffraction wavelength of light is small compared to the sizes of material obstacles like slit widths. Light rays are null geodesics which means

$$ds^2 = 0$$

The inertial frame "Lorentz transformations" are[8]

$$dx' = \gamma(dx - vdt)$$

$$dt' = \gamma\left(dt - \frac{vdx}{c^2}\right)$$

[8] v is the constant relative velocity between Alice and Bob each measuring the same two events 1 and 2 separated by ds.

$$\gamma \equiv \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$$

One must use the same c in the general Lorentz transformation in order to keep the differential spacetime interval ds^2 invariant. Therefore, c itself is Lorentz invariant (aka a Lorentz group scalar). [vii]

The situation for a non-inertial frame transformation is very different. The same differential invariant for the non-inertial observer is

$$ds^2 = g_{tt}c^2dt"^2 + g_{tx}cdt"dx" + g_{xx}dx"^2$$

The light ray obeys as before

$$ds^2 = 0$$

Therefore, we have a quadratic equation for the unknown coordinate speed of light c" in the non-inertial frame

$$g_{tt}c^2dt"^2 + g_{tx}cdt"dx" + g_{xx}dx"^2 = 0$$

$$g_{tt}c^2 + g_{tx}c\frac{dx"}{dt"} + g_{xx}\left(\frac{dx"}{dt"}\right)^2 = 0$$

The coordinate speed of light in the non-inertial frame has generally two roots

$$c" \equiv \frac{dx"}{dt"}$$

$$c"^2 + \frac{g_{tx}}{g_{xx}}cc" + \frac{g_{tt}}{g_{xx}}c^2 = 0$$

$$c" = c\left(-\frac{g_{tx}}{2g_{xx}} \pm \frac{1}{2}\sqrt{\left(\frac{g_{tx}}{g_{xx}}\right)^2 - 4\frac{g_{tt}}{g_{xx}}}\right)$$

In the inertial frame

$$g_{tx} = 0$$

$$\frac{g_{tt}}{g_{xx}} = -1$$

Therefore,

$$c" \to \pm c$$

The S field restores Einstein's coupling of matter to gravity to the non-inertial frame transformations of his 1916 General Relativity. The simplest mathematical proof of this fact is in the following toy model that is faithful to my allegation that seems to have been missed by the mainstream relativity physics community because in their quest for the cold "marble" mathematical elegance combined with an aristocratic disdain for messy "mud physics" (allegedly Wolfgang Pauli's name for solid state physics) they have prematurely set

$$\frac{\mathrm{G}}{\mathrm{c}^4} = 1$$

In a contorted contrived unnatural system of units.

In the simplest case that illustrates how the S field compensates for the non-invariance of the vacuum speed of light in the non-inertial frame transformations required by tensor calculus for Einstein's General Theory of Relativity of the gravity field (aka 4D space-time curvature).[9] Let

$$g_{tt} = 1$$
$$g_{xx} = -1$$
$$g_{tx} \equiv \zeta$$

$$c" = c\left(\frac{\zeta}{2} \pm \frac{1}{2}\sqrt{(\zeta)^2 + 4}\right)$$

$$\frac{dc"}{d\zeta} = \frac{c}{2}\left(1 \pm \frac{\zeta}{2\sqrt{(\zeta)^2 + 4}}\right)$$

$$\frac{d}{d\zeta}\left(\frac{S}{c"^4}\right) = S\frac{d}{d\zeta}\left(\frac{1}{c"^4}\right) + \frac{1}{c"^4}\frac{dS}{d\zeta}$$

$$\frac{d}{d\zeta}\left(\frac{1}{c"^4}\right) = -4\frac{1}{c"^5}\frac{dc"}{d\zeta} = -\frac{c}{c"^5}\left(1 \pm \frac{\zeta}{\sqrt{(\zeta)^2 + 4}}\right)$$

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[9] This part is completely my original work. To my knowledge there is no literature on this because no one has ever asked the questions I am asking only because of trying to make sense of the US Navy UFO disclosure. These equations were hidden in plain sight since 1916.

$$\frac{d}{d\zeta}\left(\frac{S}{c"^4}\right) = -S\left[\frac{c}{c"^5}\left(1 \pm \frac{\zeta}{\sqrt{(\zeta)^2+4}}\right)\right] + \frac{1}{c"^4}\frac{dS}{d\zeta}$$

Invariance of the Einstein matter-gravity coupling under non-inertial frame transformations means in this concrete example

$$\frac{d}{d\zeta}\left(\frac{S}{c"^4}\right) = -S\left[\frac{c}{c"^5}\left(1 \pm \frac{\zeta}{\sqrt{(\zeta)^2+4}}\right)\right] + \frac{1}{c"^4}\frac{dS}{d\zeta} = 0$$

Therefore,

$$-\left[\frac{c}{c"}\left(1 \pm \frac{\zeta}{\sqrt{(\zeta)^2+4}}\right)\right] + \frac{1}{S}\frac{dS}{d\zeta} = 0$$

$$\frac{c}{c"} = \frac{1}{\left(\frac{\zeta}{2} \pm \frac{1}{2}\sqrt{(\zeta)^2+4}\right)}$$

$$-\left[\frac{1}{\left(\frac{\zeta}{2} \pm \frac{1}{2}\sqrt{(\zeta)^2+4}\right)}\left(1 \pm \frac{\zeta}{\sqrt{(\zeta)^2+4}}\right)\right]d\zeta + \frac{dS}{S} = 0$$

$$f(\zeta) \equiv -\left[\frac{1}{\left(\frac{\zeta}{2} \pm \frac{1}{2}\sqrt{(\zeta)^2+4}\right)}\left(1 \pm \frac{\zeta}{\sqrt{(\zeta)^2+4}}\right)\right]$$

$$f(\zeta)d\zeta + \frac{dS}{S} = 0$$

We can formally integrate this differential equation to get in an active physically real objective non-inertial frame transformation between Ted (ζ_1) and Carol (ζ_2) in Einstein's "local coincidence") both measuring the same distant events using far field "light" (EM) rays in vacuum in the geometrical optics approximation

$$lnS = \int f(\zeta)d\zeta + a$$

$$\Delta S(\zeta_1\zeta_2) = Ae^{\int_{\zeta_1}^{\zeta_2} f(\zeta)d\zeta}$$

That compensates the non-inertial frame vacuum speed of light shift

$$\Delta c"(\zeta_1\zeta_2) \equiv c"(\zeta_1) - c"(\zeta_2)$$

$$A(\varepsilon, \mu \ldots.) = e^{a(\varepsilon,\mu\ldots)}$$

ε_r, μ_r ... are the dimensionless complex function of spacetime relative to vacuum electric permittivity, magnetic permeability, et-al of the medium that is the domain of the complex function S field that is a special relativity *global* inertial frame invariant like c the vacuum speed of light, but, again like c, is not a general relativity non inertial frame *local* invariant.[10]

For example, using *Keith Wanser's computation* for a static homogeneous isotropic material[11]

$$A(\varepsilon, \mu \ldots.) = \frac{1}{2}\left(\varepsilon_r{}^2 + \left(\frac{1}{\mu_r}\right)^2\right)$$

The inertial frame transformations of Special Relativity are the limit $\zeta \to 0$

$$f(0) \equiv -\left[\frac{1}{\left(\frac{0}{2} \pm \frac{1}{2}\sqrt{(0)^2 + 4}\right)}\left(1 \pm \frac{0}{\sqrt{(0)^2 + 4}}\right)\right] = -\left[\frac{1}{\left(\pm\frac{1}{2}\sqrt{+4}\right)}(1)\right] = \pm 1$$

The *tetrad* mixed inertial Alice to non-inertial Ted transformations[12] are

$$\int_0^{\zeta} f(\zeta')d\zeta' \quad \cong \quad \Delta f(\Delta\zeta)\,\Delta\zeta$$

$$\Delta f(\Delta\zeta) \equiv f(\Delta\zeta) - f(0) = f(\Delta\zeta) - 1$$

$$\Delta S(0\zeta) = Ae^{\int_0^{\zeta} f(\zeta\prime)d\zeta\prime} \cong Ae^{\Delta f(\Delta\zeta)\,\Delta\zeta}$$

Inertial frame transformations by definition have

$$\Delta f(\Delta\zeta)\,\Delta\zeta \quad = 0$$

These purely classical tensor calculus constraints miraculously are consistent with Stephen Hawking's discovery of the quantum field evaporation of the event horizons of black holes which also form the basis of Lenny Susskind's "world hologram" idea, i.e.,

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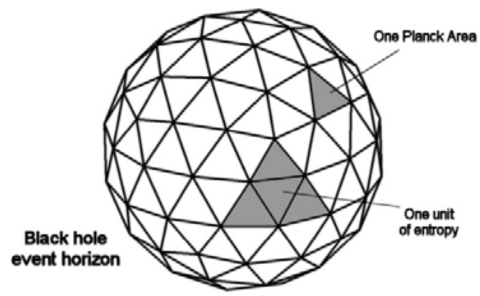
[10] General relativity can be understood as a local gauge theory of the global translation group of special relativity with the zero "dislocation" torsion field constraint leaving only the "disclination" curvature field in the sense of crystal lattice theory (e.g., Hagen Kleinert's "world crystal"& TWB Kibble's papers).

[11] Keith Wanser has not yet shown his derivation of his simple equation of state for S from the Medina-Stephany paper on covariant electrodynamics of the electromagnetic field stress-energy tensor inside what we now recognize as "space-time metamaterials."

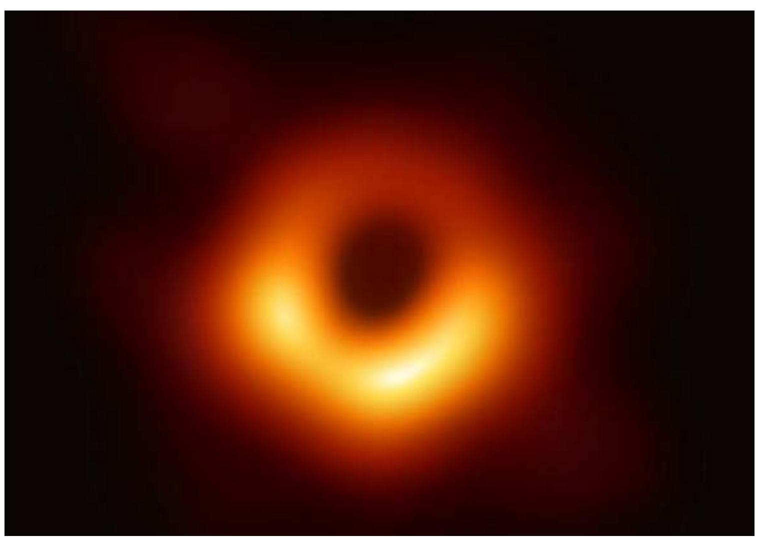
[12] See Chapter 2 of Carlo Rovelli's Quantum Gravity Lecture notes (online) for more technical details including "local coincidence" that would unduly increase the complexity and length of this introductory pedagogical lecture.

ER (bulk “voxels”) = EPR(boundary “pixels) duality and expressed in Hawking’s:

Entropy of Black Hole Horizon /Boltzmann’s Quantum of Entropy
= Area of Black Hole Event Horizon/4xQuantum Gravity Planck Area



$$S_{\mathrm{BH}} = \frac{Ac^3}{4\hbar G}$$



Quantum electrodynamics gives a clear physical explanation of why the vacuum speed of light obeys James Clerk Maxwell's 1865 unification of electricity, magnetism, and light in his simple equation

$$c^2 = \frac{1}{\varepsilon_0 \mu_0}$$

The numerical value of c is contingent on the internal densities of mainly virtual electron-positron pairs that forward scatter real photons[viii] with constructive interference. We now know that different phases of the quantum vacuum with different values of electric permittivity ε_0 and magnetic permeability μ_0 are allowed and may even exist in different parts of the universe. Hawking's discovery 50 or so years ago led Paul Davies, Stephen Fulling and William Unruh to the realization that the distinction between real and virtual particles is not invariant under the non-inertial frame transformations required by tensor calculus in Einstein's General Relativity.[ix] Therefore, we can intuitively understand the S field even in vacuum as the compensating field including both real and virtual charged particles on an equal footing consistent with the Copernican Principle. In other words, the effective electric permittivity ε_0 and magnetic permeability μ_0 of the quantum vacuum depends upon the G-force "proper" off-geodesic acceleration of the non-inertial observer's particle detectors. In fact, electric permittivity ε_0 and magnetic permeability μ_0 the non-zero temperature Hawking black body radiation of real photons seen by the non-inertial detector are simply virtual zero point photons of zero temperature for the inertial observer's detector that can be in local coincidence with the inertial detector. This leads to the so-called Fire Wall Paradox connected with the issue of whether Einstein's classical equivalence principle is violated by quantum processes. The S-field inside metamaterials simply treats the real electric charges on an equal footing with the virtual electron-positron zero point fluctuations that coexist with the real electric charges inside the metamaterial.

The weak gravity field approximation[13]

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

$$h_{\mu\nu} \ll \eta_{\mu\nu}$$

$$h_{\mu\nu} \cong 0 \; in \; an \; inertial \; frame$$

The globally flat Minkowski spacetime of Special Relativity for the inertial observer is

$$\eta_{\mu\nu} \equiv \begin{pmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

[13] I am using the tensor calculus notation explained here https://scanalyst.fourmilab.ch/t/the-power-of-notation-the-einstein-field-equations/1300

More exactly in terms of the corrections from the 4th rank Riemann curvature tensor $R_{\mu\nu\lambda\sigma}$ even in the Local Inertial Frame (aka LIF)[14]

$$g_{00} = -1 - R_{0i0j}\delta x^i \delta x^j$$
$$g_{0k} = -\frac{2}{3} R_{0ikj}\delta x^i \delta x^j \qquad (2.1.1)$$
$$g_{kl} = \delta_{kl} - \frac{1}{3} R_{kilj}\delta x^i \delta x^j .$$

These coordinates are called *Fermi Normal Coordinates*.

Gravitation and Inertia, Ignazio Ciufolini, John Archibald Wheeler

Einstein's equivalence principle is that a freely falling timelike geodesic zero G-Force LIF exists in a small enough region of 4D curved spacetime when the displacements from the origin in (2.1.1) δx^i are small compared to the locally varying radii of curvature $\sim {R_{\mu\nu\lambda\sigma}}^{-1/2}$

In analogy with the Lorentz gauge condition of classical electrodynamics

$$\overline{h}_{\mu\nu} \equiv h_{\mu\nu} - \frac{1}{2} h_\lambda^\lambda \eta_{\mu\nu}$$

Impose the constraint

$$\overline{h}_\alpha^{\mu\alpha} = 0$$

This give the approximate gravity wave hyperbolic wave equation

$$\left[\frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \nabla^2\right]\overline{h}_{\mu\nu} = -16\pi\left(\frac{G}{c^4}\right)T_{\mu\nu}$$

However, as we have shown already this equation found in all the textbooks is mathematically inconsistent and must be replaced, especially inside matter with

$$\frac{1}{c''^2}\frac{\partial^2}{\partial t^2}\left(S\overline{h}_{\mu\nu}\right) - \nabla^2\left(S^{1/2}\overline{h}_{\mu\nu}\right) = -16\pi\left(\frac{G}{c''^4}\right)ST_{\mu\nu}$$

$$\frac{\partial^2}{\partial t^2}\left(S\overline{h}_{\mu\nu}\right) = S\frac{\partial^2}{\partial t^2}\left(\overline{h}_{\mu\nu}\right) + \overline{h}_{\mu\nu}\frac{\partial^2 S}{\partial t^2} + 2\left(\frac{\partial S}{\partial t}\frac{\partial \overline{h}_{\mu\nu}}{\partial t}\right)$$

$$\nabla^2\left(S^{1/2}\overline{h}_{\mu\nu}\right) = S^{1/2}\nabla^2\left(\overline{h}_{\mu\nu}\right) + \overline{h}_{\mu\nu}\nabla^2\left(S^{1/2}\right) + 2\vec{\nabla}S^{1/2}\cdot\vec{\nabla}\overline{h}_{\mu\nu}$$

---

[14] Non-rotating.

Note that if all the partial derivatives of S vanish[15]

$$\frac{S}{c"^2}\frac{\partial^2}{\partial t^2}\left(\overline{h}_{\mu\nu}\right) - S^{1/2}\nabla^2\left(\overline{h}_{\mu\nu}\right) = -16\pi\left(\frac{G}{c"^4}\right)ST_{\mu\nu}$$

$$\frac{1}{c"^2}\frac{\partial^2}{\partial t^2}\left(\overline{h}_{\mu\nu}\right) - S^{-1/2}\nabla^2\left(\overline{h}_{\mu\nu}\right) = -16\pi\left(\frac{G}{c"^4}\right)T_{\mu\nu}$$

In the static limit[16] this is the modified Poisson equation

$$\nabla^2\left(\overline{h}_{\mu\nu}\right) = 16\pi\left(\frac{G}{c"^4}\right)S^{1/2}T_{\mu\nu}$$

The Newtonian-Poisson gravity limit is dominated by the 00 component of this tensor equation.

For static homogenous isotropic matter from fermion particles the equation of state implies

$$T_{00} = \frac{\rho c"^2}{S^{1/2}} + 3\frac{P}{c"^2}S^{1/2}$$

Where ρ is the fermionic mass density and P is the pressure including the quantum zero point vacuum fluctuations of the virtual fermion-antifermion pairs inside the quantum vacuum of the metamaterial. The static limit is then[17]

$$\nabla^2\left(\overline{h}_{00}\right) = 16\pi\left(\frac{G}{c"^4}\right)S^{1/2}\left(\frac{\rho c"^2}{S^{1/2}} + 3\frac{P}{c"^2}S^{1/2}\right) = 16\pi\left(\frac{G}{c"^2}\right)\left(\rho + 3\frac{P}{c"^2}S\right)$$

Notice that the S field cancels out of the fermionic mass density term as noticed by Keith Wanser, who however, neglected the pressure term in which the S field remains in full force. Wanser noted that many passive materials in thermodynamical equilibrium have a negligible pressure term consistent with old Cavendish experiments that suggest

Active gravity source mass = passive gravity test mass = inertial mass.

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[15] The time derivative terms have an extra factor of $S^{1/2}$ because the dimensionless metric field has a factor of c^{-2} which is included in the spatial Laplacian term in addition to the c^{-2} term in the time derivative.

[16] The static limit is for evanescent near fields, i.e., coherent quantum states of off-shell virtual gravitons.

[17] $\overline{h}_{00} = 4\phi_{Newton}$ Cal Tech Lecture, C.M. Hirata, Nov 5, 2012, online.

However, *we predict* that is no longer true for artificial metamaterials engineered to have a large pressure term for the fermions. The bosons of the electromagnetic field is a completely different story all together and I will explore that next.

Feynman's Cal Tech Lectures on Gravity

Feynman used his quantum electrodynamics for the spin 1 electromagnetic vector gauge field in his perturbation theory approach to gravity as a spin 2 tensor field on a rigid globally flat Minkowski spacetime. His equations only deal with the inertial frame transformations of the Lorentz group. He then derives Einstein's curved spacetime emerging from summing an infinite number of his tree diagrams without closed loops. He starts with

$$\left[\frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \nabla^2\right]\bar{h}_{\mu\nu} = -16\pi\left(\frac{G}{c^4}\right)T_{\mu\nu}$$

Then in Fourier transform 4-momentum space

$$\left[\frac{\omega^2}{c^2} - \vec{k}^2\right]\tilde{\bar{h}}_{\mu\nu}(\omega,\vec{k}) = -16\pi\left(\frac{G}{c^4}\right)\tilde{T}_{\mu\nu}(\omega,\vec{k})$$

$$\tilde{\bar{h}}_{\mu\nu}(\omega,\vec{k}) = \frac{-16\pi\left(\frac{G}{c^4}\right)\tilde{T}_{\mu\nu}(\omega,\vec{k})}{\frac{\omega^2}{c^2} - \vec{k}^2 \pm i\epsilon}$$

The Feynman propagator in 4-momentum space is

$$\tilde{\mathrm{F}}(\omega,\vec{k}) = \frac{-16\pi\left(\frac{G}{c^4}\right)}{\frac{\omega^2}{c^2} - \vec{k}^2 \pm i\epsilon}$$

The poles of the propagator in the complex variable ω plane correspond to "on mass shell" far-field real gravitons in which we have the dispersion relation

$$\frac{\omega^2}{c^2} - \vec{k}^2 \pm i\epsilon = 0$$

The different kinds of propagators, advanced destiny, retarded history, and their combination actually used by Feynman to define antiparticles of positive energy moving forward in time as negative energy particles moving backwards in time depend on the choice of contour going around the poles displaced by $\pm i\epsilon$ according to the mathematics of complex functions.

However, the warp drive case which is our prime interest here corresponds to the evanescent near gravity fields made from coherent states of virtual gravitons in which the above dispersion relation is violated.

Feynman's propagator in space-time is the Fourier transform

$$F(t-t',\vec{x}-\vec{x}')\sim\int \tilde{F}(\omega,\vec{k})e^{i\omega(t-t')}\,e^{i\vec{k}\cdot(\vec{x}-\vec{x}')}d\omega d^3k$$

$$\left[\frac{1}{c^2}\frac{\partial^2}{\partial t^2}-\nabla^2\right]F(t-t',\vec{x}-\vec{x}')=\delta(t-t')\delta^3(\vec{x}-\vec{x})$$

Therefore, we have the space-time convolution integral

$$G_{\mu\nu}(t,\vec{x})=\int F(t-t',\vec{x}-\vec{x}')T_{\mu\nu}(t',\vec{x}')dt'\,d^3x'$$

$t,\vec{x}$ is the gravitational field event $t',\vec{x}'$ is the stress-energy source event. The integral is over the domain of $T_{\mu\nu}(t',\vec{x}')\neq 0$. On the other hand, in contrast $t,\vec{x}$ can be in the interior of the stress-energy source domain, or it can be exterior in the vacuum outside that domain. Our main interest is the former in which the stress-energy source domain is localized inside the thin shell metamaterial fuselage of the warp drive spaceship.

The above Feynman model is over simplified, and the math gets very complicated when we add the non-inertial frame transformations required by the physics.

If we stick with Feynman's locality in 4-momentum space with nonlocal convolution integrals in spacetime and now include non-inertial frame transformations

$$\frac{1}{c''^2}\frac{\partial^2}{\partial t^2}\left(S\otimes\bar{h}_{\mu\nu}\right)-\nabla^2\left(S^{1/2}\otimes\bar{h}_{\mu\nu}\right)=-16\pi\left(\frac{G}{c''^4}\right)S\otimes T_{\mu\nu}$$

$$f(x)\otimes g(x)\equiv\int f(x-x')g(x')d^4x'$$

$$\frac{1}{c''^2}\left[S\frac{\partial^2}{\partial t^2}\left(\bar{h}_{\mu\nu}\right)+\bar{h}_{\mu\nu}\frac{\partial^2 S}{\partial t^2}+2\left(\frac{\partial S}{\partial t}\frac{\partial\bar{h}_{\mu\nu}}{\partial t}\right)\right]-S^{\frac{1}{2}}\nabla^2\left(\bar{h}_{\mu\nu}\right)+\bar{h}_{\mu\nu}\nabla^2\left(S^{\frac{1}{2}}\right)+2\vec{\nabla}S^{\frac{1}{2}}\cdot\vec{\nabla}\bar{h}_{\mu\nu}$$
$$=-16\pi\left(\frac{G}{c''^4}\right)S\otimes T_{\mu\nu}$$

In Fourier momentum space where S had a modulation signal in addition to the carrier pump signal

$$\omega' = \omega + \omega_m$$
$$\vec{\mathrm{k}}' = \vec{\mathrm{k}} + \vec{\mathrm{k}}_m$$

$$\left\{\frac{1}{c"^2}[\omega^2 + \omega'^2 + 2\omega\omega']\tilde{S} - \left[k^2 + {k'}^2 + 2\vec{\mathrm{k}} \cdot \vec{\mathrm{k}}' \cdot\right]\tilde{S}^{1/2}\right\}\tilde{\bar{h}}_{\mu\nu} = -16\pi\left(\frac{G}{c"^4}\right)\tilde{S}\tilde{T}_{\mu\nu}$$

$$\tilde{\bar{h}}_{\mu\nu} = -\frac{16\pi\left(\frac{G}{c"^4}\right)\tilde{S}\tilde{T}_{\mu\nu}}{\frac{1}{c"^2}[\omega^2 + \omega'^2 + 2\omega\omega']\tilde{S} - \left[k^2 + {k'}^2 + 2\vec{\mathrm{k}} \cdot \vec{\mathrm{k}}' \cdot\right]\tilde{S}^{1/2}}$$

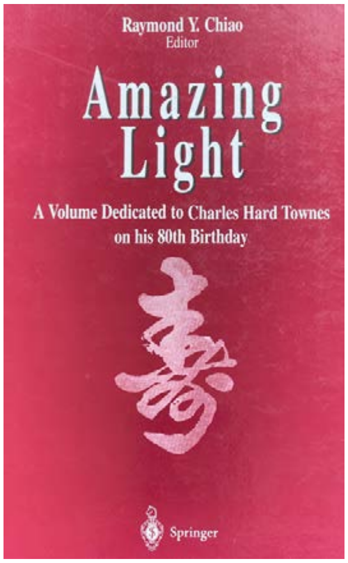
The modified Feynman propagator is then

$$\tilde{\mathrm{F}}\left(\omega, \vec{k}\right)_S = \frac{16\pi\left(\frac{G}{c"^4}\right)\tilde{S}\left(\omega', \vec{k'}\right)}{\frac{1}{c"^2}[\omega^2 + \omega'^2 + 2\omega\omega']\tilde{S}\left(\omega', \vec{k'}\right) - \left[k^2 + {k'}^2 + 2\vec{\mathrm{k}} \cdot \vec{\mathrm{k}}' \cdot\right]\tilde{S}\left(\omega', \vec{k'}\right)^{1/2} \pm i\epsilon}$$

In space-time

$$G_{\mu\nu}(x)_S \sim \int F(x - x')_S \, T_{\mu\nu}(x') d^4x$$

Electromagnetic Structure of the S Field



10.3 Theory of Wave Packet Propagation in Transparent, Population-inverted Media

The refractive index of a completely inverted two-level medium can be obtained from a Lorentz model in which the sign of the oscillator strength of the transition is reversed due to the population inversion [2]

$$n(\omega) = \left(1 - \frac{\omega_p^2}{\omega_0^2 - \omega^2 - i\gamma\omega}\right)^{1/2}, \tag{10.5}$$

where γ is a (small) phenomenological linewidth, ω_0 is the resonance frequency of the medium, and ω_p is the effective plasma frequency,

$$\omega_p = (4\pi|f|Ne^2/m)^{1/2}, \tag{10.6}$$

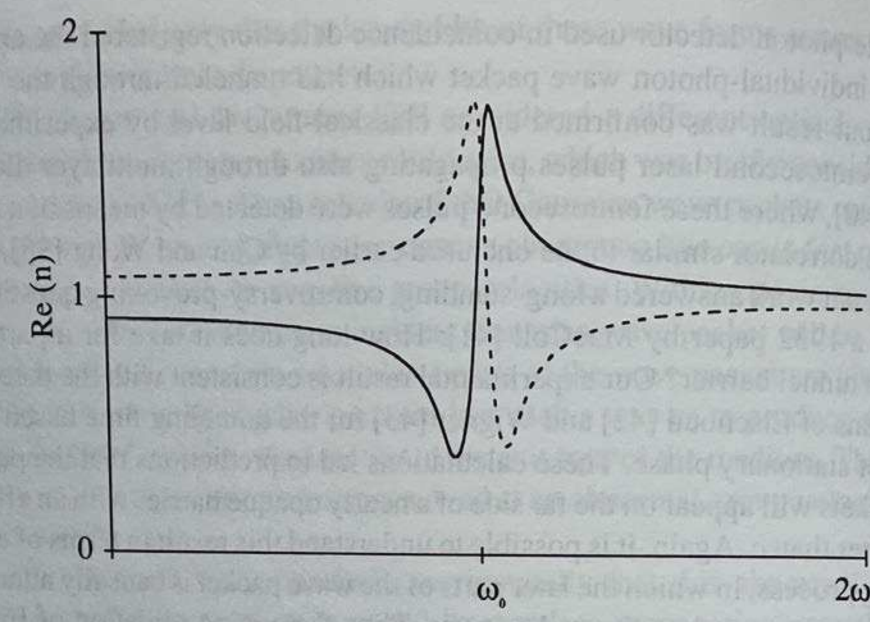


FIGURE 10.2. Real part of the refractive index versus frequency for a completely inverted two-level atomic or molecular medium (solid line), compared with that for the same medium with completely uninverted populations (dashed line).

Ray Chiao's resonant ω_0 spectral index of refraction equation for a laser/Frohlich non-equilibrium macro-quantum coherent condensate of emergent bosons in a pumped many-particle system is

$$\tilde{n}(\omega)^2 = \tilde{\varepsilon}(\omega)\tilde{\mu}(\omega) = 1 - \frac{\omega_p^2}{(\omega_0^2 - \omega^2 + i\gamma\omega)}$$

The Schawlow-Townes laser line narrowing equation in this case is comes from Heisenberg's uncertainty principle for number and phase of a quantum harmonic oscillator

$$\Delta N \Delta\theta \geq \frac{1}{2}$$

For the macro-quantum coherent Glauber state with Poisson statistics[18]

$$\Delta N = \sqrt{\langle N \rangle}$$

$$\gamma \cong \frac{1}{2\tau\sqrt{\langle N \rangle}}$$

$$\frac{1}{\tau}\ is\ the\ resonance\ width\ in\ the\ absence\ of\ the\ Glauber\ coherent\ state$$

$$\langle N \rangle\ is\ the\ number\ of\ bosons\ in\ the\ same\ single\ particle\ mode\ \omega$$

In the case of a homogeneous isotropic non-magnetic material, i.e.,

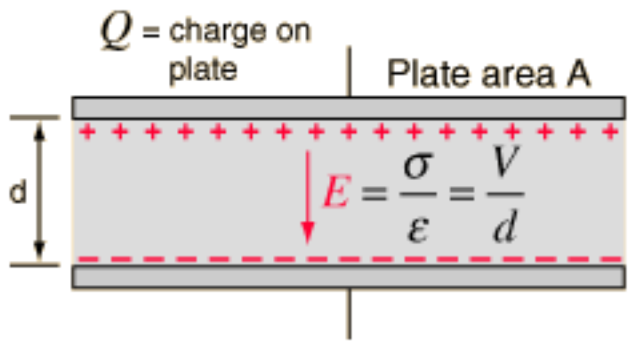
$$\mu_r \equiv \frac{\mu}{\mu_0} = 1$$

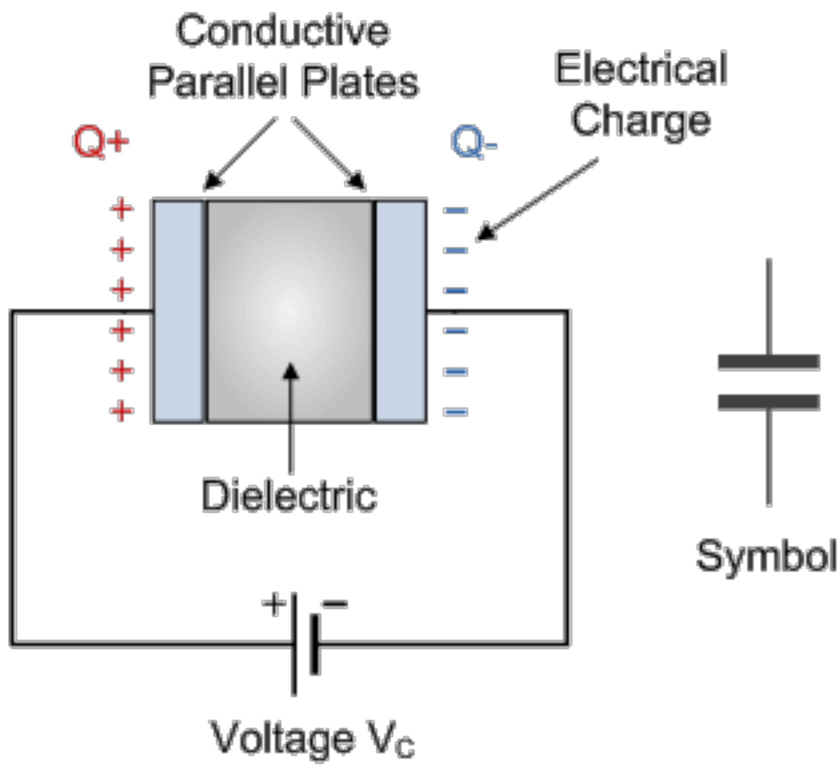
we have a tentative toy model

$$\tilde{\varepsilon}_r(\omega) = \frac{\tilde{\varepsilon}(\omega)}{\varepsilon_0} = 1 - \frac{\omega_p^2}{(\omega_0^2 - \omega^2 + i\gamma\omega)}$$

$$\tilde{S}(\omega) = \frac{1}{2}\left[\left(1 - \frac{\omega_p^2}{(\omega_0^2 - \omega^2 + i\gamma\omega)}\right)^2 + 1\right]$$

[18] https://en.wikipedia.org/wiki/Coherent_state





Imagine an electrical capacitor with conducting plate area A, plate separation d with dielectric permittivity $\tilde{\varepsilon}(\omega)$ material filling the volume Ad between the plates pumped by an AC voltage $\tilde{V}(\omega)$.[19]The uniform oscillating electric field between the plates is

[19] The **Feynman propagator** I calculated above includes addition **parametric oscillation** in which for example the separation d between the plates of the electrical capacitor can oscillate at the "modulation" frequency with the AC voltage generator as the "carrier" Frohlich pump frequency. This leads to the **Floquet emergence of topologically protected** "**room temperature superconducting condensate**" (immune to impurity scattering) **edge states** (surface plasmons?) above critical voltage power input analogous to the lasing threshold. This is one example in which **Lenny Susskind's ER = EPR** world hologram theory for superstrings has had some practical success in the low energy "mud physics" (W. Pauli) relevant to the military UFO threat now recognized as real by the US DOD, CIA, NASA, NID et-al.

$$\tilde{E}(\omega) = \frac{\tilde{V}(\omega)}{d}$$

The electric energy density is then in SI(MKS) electromagnetic units

$$\tilde{T}_{00}(\omega) = \frac{1}{2}\,\tilde{\varepsilon}(\omega)\left(\frac{\tilde{V}(\omega)}{d}\right)^2$$

The 00 component of the induced gravity field is then

$$\tilde{G}_{00}(\omega) = 8\pi\,\frac{G}{c"^4}\tilde{S}(\omega)\tilde{T}_{00}(\omega)$$

$$= 4\pi\, G\varepsilon_0^3\mu_0^2\left[\left(1 - \frac{\omega_p^2}{(\omega_0^2 - \omega^2 + i\gamma\omega)}\right)^2 + 1\right]\left(1 - \frac{\omega_p^2}{(\omega_0^2 - \omega^2 + i\gamma\omega)}\right)\left(\frac{\tilde{V}(\omega)}{d}\right)^2$$

When the AC voltage generator is tuned to resonance $\omega \to \omega_0$

$$\left[\left(1 - \frac{\omega_p^2}{(\omega_0^2 - \omega^2 + i\gamma\omega)}\right)^2 + 1\right]\left(1 - \frac{\omega_p^2}{(\omega_0^2 - \omega^2 + i\gamma\omega)}\right) \to -\left(\frac{\omega_p^2}{i\gamma\omega_0}\right)^3 = i\left(\frac{\omega_p^2\tau\sqrt{\langle N_{\omega_0}\rangle}}{\omega_0}\right)^3$$

Where $N_{\omega_0} \gg 1$

Define

$$\delta\omega^2 = \omega_0^2 - \omega^2$$

$$0 \leq \left|\frac{\delta\omega^2}{\omega_0^2}\right| \ll 1$$

$$\left(\frac{\omega_p^2}{\delta\omega^2 + i\gamma\omega_0}\right)^3 = \left|\frac{\omega_p^2}{\delta\omega^2 + i\gamma\omega_0}\right|^3 e^{3iarg\left(\frac{\omega_p^2}{\delta\omega^2 + i\gamma\omega_0}\right)}$$

$$\frac{\omega_p^2}{\delta\omega^2 + i\gamma\omega_0} = \frac{\omega_p^2(\delta\omega^2 + i\gamma\omega_0)}{\delta\omega^4 + (\gamma\omega)^2}$$

$$\left|\frac{\omega_p^2}{\delta\omega^2 + i\gamma\omega_0}\right|^2 = \frac{\omega_p^4((\delta\omega^2)^2 + (\gamma\omega_0)^2)}{((\delta\omega^2)^2 + (\gamma\omega_0)^2)^2}$$

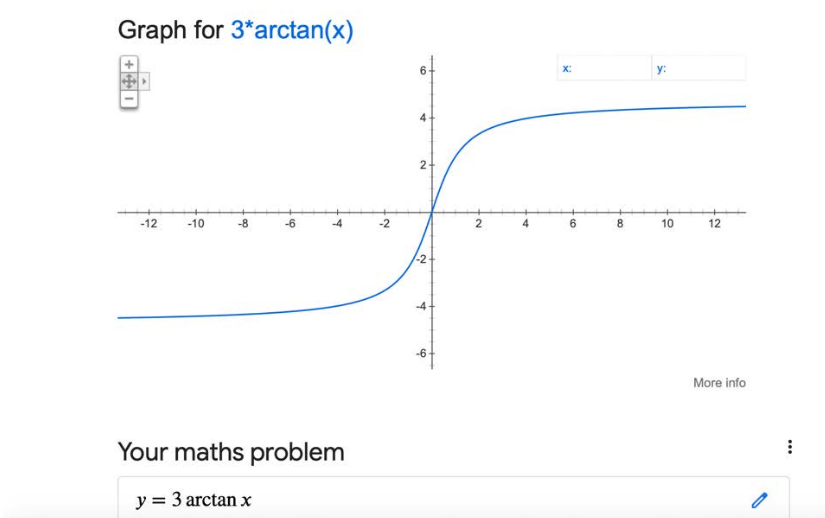
$$\left|\frac{\omega_p^2}{\delta\omega^2 + i\gamma\omega_0}\right| = \frac{\omega_p^2\sqrt{(\delta\omega^2)^2 + (\gamma\omega_0)^2}}{(\delta\omega^2)^2 + (\gamma\omega_0)^2} = \frac{\omega_p^2}{\sqrt{(\delta\omega^2)^2 + (\gamma\omega_0)^2}} > 0$$

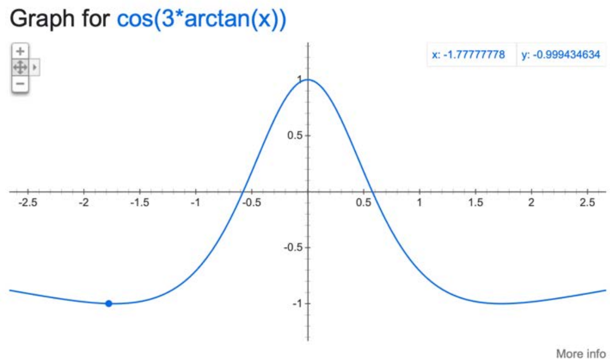
$$tan\left(arg\,\frac{\omega_p^2}{\delta\omega^2 + i\gamma\omega_0}\right) = \frac{\gamma\omega_0}{\delta\omega^2}$$

$$arg\,\frac{\omega_p^2}{\delta\omega^2 + i\gamma\omega_0} = arctan\left(\frac{\gamma\omega_0}{\delta\omega^2}\right)$$

$$y \equiv 3\;arg\,\frac{\omega_p^2}{\delta\omega^2 + i\gamma\omega_0} = 3arctan\left(\frac{\gamma\omega_0}{\delta\omega^2}\right)$$

$$x(\omega, N_\omega) \equiv \frac{\gamma\omega_0}{\delta\omega^2} = \frac{\omega_0}{2\tau\sqrt{\langle N_{\omega_0}\rangle}\delta\omega^2}$$





x is plotted on the horizontal. At resonance $\delta\omega^2 = 0,\ therefore$
$x \to \pm\infty\ corresponding\ to\ phase\ angle \frac{3\pi}{2}\ with\ asymptote\ \cos\frac{3\pi}{2}$
$= -\frac{1}{2}$ *which should produce an* **antigravity blue shift**. *However, we want to keep*

$$\delta\omega^2 \neq 0$$

slightly off resonance and use the Frohlich condensate number N_ω *to move* x *around so that the cosine* goes positive giving **attractive gravity redshift**. [x]

We can ignore the "1" terms to a good approximation in the region of a strong resonant peak. Therefore,

$$\left[\left(1 - \frac{\omega_p^2}{(\omega_0^2 - \omega^2 + i\gamma\omega)}\right)^2 + 1\right]\left(1 - \frac{\omega_p^2}{(\omega_0^2 - \omega^2 + i\gamma\omega)}\right) \cong \left(\frac{\omega_p^2}{(\omega_0^2 - \omega^2 + i\gamma\omega)}\right)^3$$

$$\left|\frac{\omega_p^2}{\delta\omega^2 + i\gamma\omega_0}\right|^3 = \left(\frac{\omega_p^2}{\sqrt{(\delta\omega^2)^2 + (\gamma\omega_0)^2}}\right)^3 = \frac{\omega_p^6}{((\delta\omega^2)^2 + (\gamma\omega_0)^2)^{3/2}}$$

$$= \frac{\omega_p^6}{(\gamma\omega_0)^3\left(1 + \frac{(\delta\omega^2)^2}{(\gamma\omega_0)^2}\right)^{3/2}} = \frac{\left(\tau N_{\omega_0}\right)^3\omega_p^6}{(\omega_0)^3\left(1 + \frac{\left(2\tau\sqrt{\langle N_{\omega_0}\rangle}\right)^2(\delta\omega^2)^2}{(\omega_0)^2}\right)^{3/2}}$$

For $\delta\omega^2 \to 0$

$$\frac{\left(2\tau\sqrt{\langle N_{\omega_0}\rangle}\right)^2 (\delta\omega^2)^2}{(\omega_0)^2} \ll 1$$

Therefore, the dimensionless resonant peak modulus is approximately

$$\left(2\tau\sqrt{\langle N_{\omega_0}\rangle}\right)^3 \omega_p^3 \left(\frac{\omega_p}{\omega_0}\right)^3$$

The width of the resonant peak is

$$\gamma = \frac{1}{2\tau\sqrt{\langle N_{\omega_0}\rangle}}$$

With phase shift

$$3arctan\left(\frac{\gamma\omega_0}{\delta\omega^2}\right) = 3arctan\left(\frac{\omega_0}{2\tau\sqrt{\langle N_{\omega_0}\rangle\delta\omega^2}}\right)$$

Einstein's field equation in this model in the weak field Newtonian-Poisson limit is then

$$\tilde{G}_{00}(\omega_0) = 4\pi G\varepsilon_0^3\mu_0^2\left(2\tau\sqrt{\langle N_{\omega_0}\rangle}\right)^3 \omega_p^3\left(\frac{\omega_p}{\omega_0}\right)^3 cos\left(3arctan\left(\frac{\omega_0}{2\tau\sqrt{N_\omega}\delta\omega^2}\right)\right)\left(\frac{\tilde{V}(\omega)}{d}\right)^2$$

As we tweak the phase $3arctan\left(\frac{\omega_0}{2\tau\sqrt{\langle N_{\omega_0}\rangle\delta\omega^2}}\right)$ to switch the cosine from positive to negative we switch from attractive gravity redshift to repulsive anti-gravity blue shift in different meta-atoms of the UFO metasurface lattice fuselage as is required by the toy model warp drive metric of Alcubierre[xi] and the one beyond it by Natario, Visser et-al. **It is the anti-gravity blue shift "lift" that is making US military personnel sick from their close contacts as reported by Stanford University's Professor Gary Nolan.**[20]

[20] To make an analogy with the "lift" of an air foil (airplane wing) the low pressure above the wing is like the attractive gravity redshift for a positive value of the cosine of the dissipative phase shift. The high pressure below

Plug in the numbers

$$4\pi G\varepsilon_0^3\mu_0^2 \cong 4 \times 3.1 \times 6.7 \times 10^{-11}(9 \times 10^{-12})^3 \times (4 \times 3.1 \times 10^{-7})^2$$
$$= 9{,}312{,}542.6 \times 10^{-61} \cong 10^{-54}$$

$$\tilde{G}_{00}(\omega_0) \cong 10^{-54}\left(2\tau\sqrt{N_{\omega_0}}\right)^3 \omega_p^3\left(\frac{\omega_p}{\omega_0}\right)^3 cos\left(3arctan\left(\frac{\omega_0}{2\tau\sqrt{\langle N_{\omega_0}\rangle\delta\omega^2}}\right)\right)\left(\frac{\tilde{V}(\omega)}{d}\right)^2$$

If we can match the performance of a laser cavity mode for our meta-atom just to get a desired performance profile take $2\tau\sqrt{\langle N_{\omega_0}\rangle} = 3 \times 10^{-3} sec$[xii]

Metal	Plasma Freq (eV)
Aluminum	15
Cesium	2.845
Gold	5.8
Lithium	6.6
Nickel	9.45
Palladium	7.7
Potassium	3.84
Silver	3.735

$$1ev \cong 2.4 \times 10^{14} Hz$$

Let's use plasma frequency of Lithium just to get a ballpark idea of what we want to design as the artificial metamaterial.

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the wing is like the antigravity blue shift that makes dangerous ionizing radiation. Never stand under a hovering UFO like Travis Taylor and others allegedly did at the Skinwalker Ranch getting them sick. In that instance the UFO is also a flying Star Gate Portal in which, according to Eric Davis, Jacques Vallee, Colm Kelleher, Robert Bigelow, Brandon Fugal, Colonel John B Alexander, Christopher "Kit" Green, Harold Puthoff, George Knapp et-al a Big Foot creature came out of at least once. https://www.amazon.com/dp/B09J484KYD/ref=dp-kindle-redirect?_encoding=UTF8&btkr=1

$$\omega_p = 2.4 \times 10^{15} Hz$$

We want to operate the warp drive engine at around 1 Hz. This gives

$$\frac{\omega_p}{\omega_0} = 2.4 \times 10^{15}$$

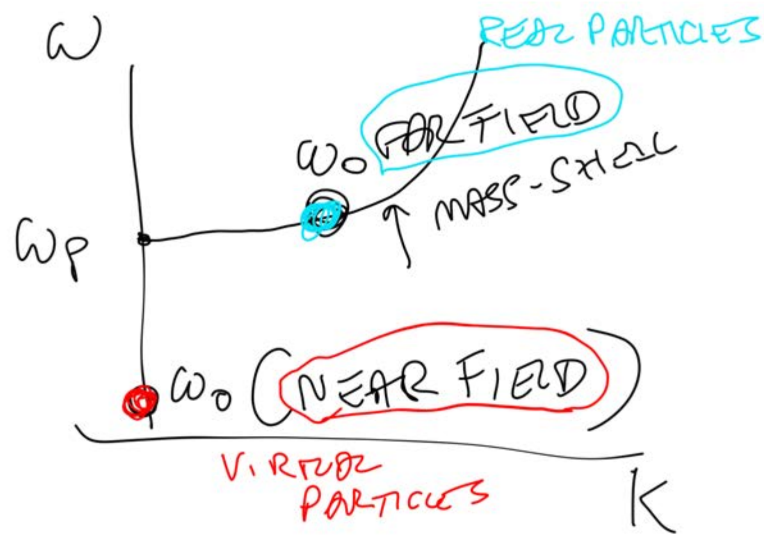
Therefore, with these numbers

$$\left(2\tau\sqrt{\langle N_{\omega_0}\rangle}\right)^3 \omega_p^3 \left(\frac{\omega_p}{\omega_0}\right)^3 \cong (3 \times 10^{-3})^3 \left((10^{15})\right)^3 (2.4 \times 10^{15})^3$$
$$\cong 4 \times 10^{83}$$

$$\tilde{G}_{00}(1Hz) \cong 10^{29} cos\left(3arctan\left(\frac{\omega_0}{3 \times 10^{-3}\delta\omega^2}\right)\right)\left(\frac{\tilde{V}(\omega)}{d}\right)^2$$

This would be ***an enormous gravity field compared to Earth's*** where $\tilde{G}_{00}(0Hz) \sim 10^{-22} \frac{1}{meter^2}$.

Of course, we got the enormous EM to gravity amplification because we assumed an off-mass-shell evanescent near field resonance way below the on-mass-shell usual far field resonance that must always be larger than the plasma frequency with a plasma frequency in the visible.[21]



[21] Ray Chiao's example illustrated above is on-mass-shell real particle unconfined radiating far field resonance where $\gamma \ll \omega_p \ll \omega_0$, we do not even know if we can achieve the off-mass-shell evanescent virtual particle confined near field resonance where where $\gamma \ll \omega_0 \ll \omega_p$.

This first stab at desired numerical design parameters for this simple capacitor "meta-atom" shows the need for AI Neural Network exploration of the non-trivial parameter space in even this simplest of all toy models. However, we have learned that it seems possible in principle to design metasurfaces with simple capacitive meta-atoms that can generate extremely strong evanescent gravity fields confined inside them that break our weak field Newtonian-Poisson approximation. Indeed, ***this could be dangerous,*** and we need to proceed with caution before moving from computer simulations of possible meta-surfaces in the large parameter space even in our simple toy model.

$$\left(\frac{\omega_p}{\omega_0}\right)^2 = \frac{8\pi\rho}{\omega_0}|\langle -|e\hat{x}|+\rangle|^2$$

Where ρ is the density of electric dipole[22] qubits of the "conscious AI post-quantum computer".[23] Therefore, now using equivalent series and/or parallel pumped oscillator LCR[24] QED equivalent circuits[25] to represent the meta-atoms

$$\tilde{G}_{00}(\omega_0) \cong 4\pi G\varepsilon_0^3\mu_0^2\left(\tau N_{\omega_0}\right)^3(8\pi\rho|\langle -|e\hat{x}|+\rangle|^2)^3 cos\left(3arctan\left(\frac{\omega_0}{\tau N_\omega \delta\omega^2}\right)\right)\left(\frac{\tilde{V}(\omega)}{d}\right)^2$$

$$\omega_0^2 = \frac{1}{LC}$$

$$\tau N_{\omega_0} = \frac{1}{\gamma} = \frac{L}{R}$$

$$Q = \frac{\omega_0}{\gamma} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

$$\tilde{G}_{00}(\omega_0) \cong 4\pi G\varepsilon_0^3\mu_0^2\left(\frac{L}{R}\right)^3(8\pi\rho|\langle -|e\hat{x}|+\rangle|^2)^3 cos\left(3arctan\left(\frac{R}{L\sqrt{LC}\delta\omega^2}\right)\right)\left[\left(\frac{Q}{Cd}\right)^2\right]$$

Our tunable parameters are then, effective magnetic inductance L, effective resistance R[26], effective electrical capacitance, detuning off-resonance $\delta\omega^2$, the applied pump voltage, also the

---

[22] E.g., protein dimers in our cylindrical metasurface microtubules generating our inner conscious qualia (experiences) according to Stewart Hameroff working with Roger Penrose.

[23] See Section 7

[24] https://en.wikipedia.org/wiki/RLC_circuit

[25] https://journals.aps.org/pra/abstract/10.1103/PhysRevA.105.033519 https://www.nature.com/articles/s41467-018-06142-z.pdf?origin=ppub

[26] R can be negative here in active metasurface.

current in the magnetic energy density and the Joule heat which disappears in the room temperature "superconducting" Frohlich condensate phase.[27] The above expression is incomplete as it ignores the magnetic permeability part of the S field and the magnetic energy density. We will fix this in later versions.

Also note that the physical meta-atoms in space on the actual metasurface layer are coupled together and we are actually talking about "virtual meta-atoms" that are the approximately independent normal modes[28] (e.g., phonons, polaritons, magnons, polarons, excitons, anyons, surface plasmons)[29] as each individual metasurface simulation will dictate.

This again will be worked out in concrete models in later versions.

Nonlinear Self-Consistency Pushes the Resonance Frequency Toward Zero While Amplifying the Resonance Peak[30]

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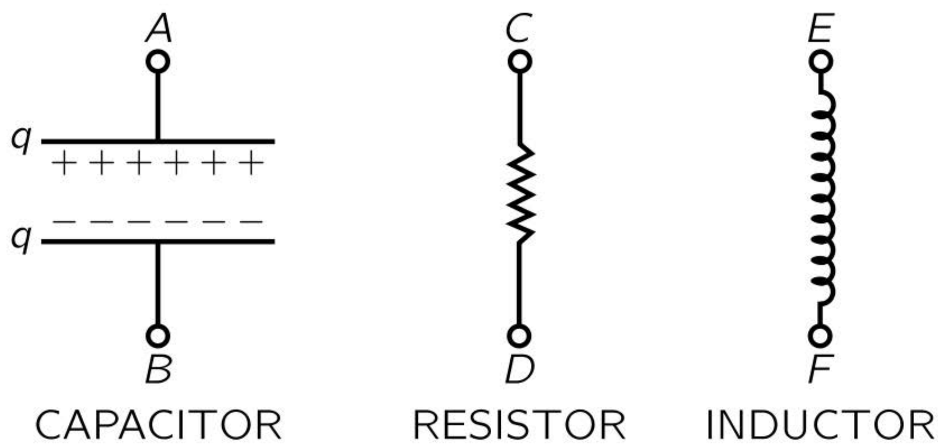
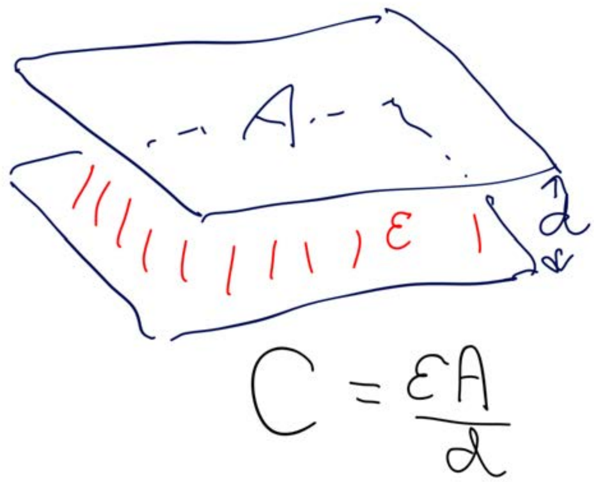
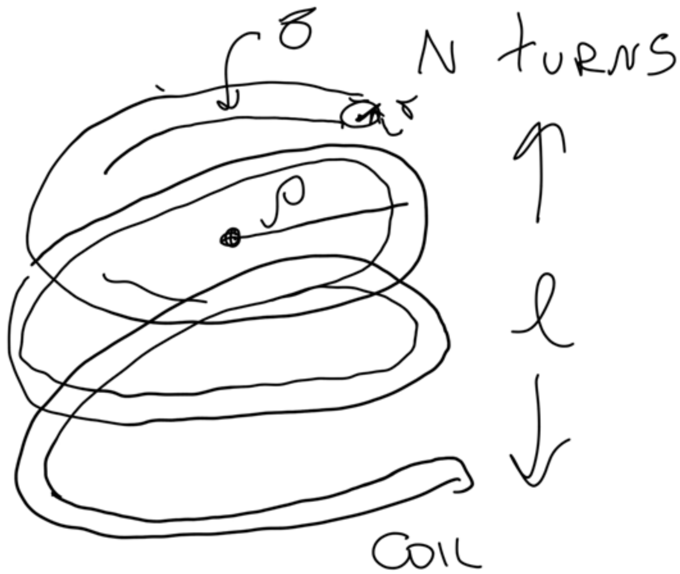


Fig. 23–4. The three passive circuit elements.

[27] https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=frohlich+condensate&oq=Frohlich+Conde
[28] https://en.wikipedia.org/wiki/Normal_mode
[29] https://en.wikipedia.org/wiki/Quasiparticle

[30] https://www.feynmanlectures.caltech.edu/I_23.html





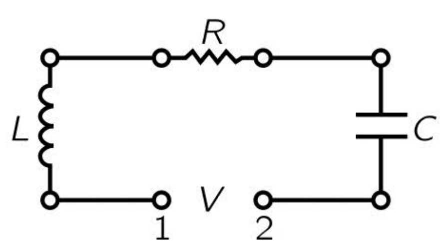
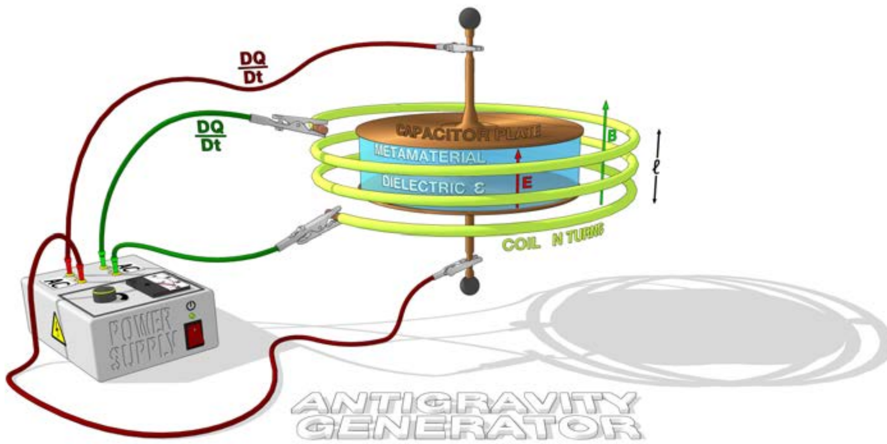


Fig. 23–5. An oscillatory electrical circuit with resistance, inductance, and capacitance.



Julien Geffray Jack Sarfatti's Gedankenexperiment

Excerpt Feynman Lectures on Physics
Volume One, Chapter 23

$$L\,d^2q/dt^2 + R\,dq/dt + q/C = V(t). \tag{23.17}$$

$$\left[L(i\omega)^2 + R(i\omega) + \frac{1}{C}\right]\hat{q} = \hat{V}$$

or

$$\hat{q} = \frac{\hat{V}}{L(i\omega)^2 + R(i\omega) + \frac{1}{C}}$$

which we can write in the form

$$\hat{q} = \hat{V}/L(\omega_0^2 - \omega^2 + i\gamma\omega), \tag{23.18}$$

where $\omega_0^2 = 1/LC$ and $\gamma = R/L$. It is exactly the same denominator as we had in the mechanical case, with exactly the same resonance properties! The correspondence between the electrical and mechanical cases is outlined in Table 23–1.

Table 23–1

General characteristic	Mechanical property	Electrical property
indep. variable	time (t)	time (t)
dep. variable	position (x)	charge (q)
inertia	mass (m)	inductance (L)
resistance	drag coeff. ($c = \gamma m$)	resistance ($R = \gamma L$)
stiffness	stiffness (k)	(capacitance)$^{-1}$ ($1/C$)
resonant frequency	$\omega_0^2 = k/m$	$\omega_0^2 = 1/LC$
period	$t_0 = 2\pi\sqrt{m/k}$	$t_0 = 2\pi\sqrt{LC}$
figure of merit	$Q = \omega_0/\gamma$	$Q = \omega_0 L/R$

We must mention a small technical point. In the electrical literature, a different notation is used. (From one field to another, the subject is not really any different, but the way of writing the notations is often different.) First, j is commonly used instead of i in electrical engineering, to denote $\sqrt{-1}$. (After all, i must be the current!) Also, the engineers would rather have a relationship between $\hat{V}$ and $\hat{I}$ than between $\hat{V}$ and $\hat{q}$, just because they are more used to it that way. Thus, since $I = dq/dt = i\omega q$, we can just substitute $\hat{I}/i\omega$ for $\hat{q}$ and get

$$\hat{V} = (i\omega L + R + 1/i\omega C)\hat{I} = \hat{Z}\hat{I}. \tag{23.19}$$

Another way is to rewrite Eq. (23.17), so that it looks more familiar; one often sees it written this way:

$$L\,dI/dt + RI + (1/C)\int^t I\,dt = V(t). \tag{23.20}$$

At any rate, we find the relation (23.19) between voltage $\hat{V}$ and current $\hat{I}$ which is just the same as (23.18) except divided by $i\omega$, and that produces Eq. (23.19). The quantity $R + i\omega L + 1/i\omega C$ is a complex number, and is used so much in electrical engineering that it has a name: it is called the *complex impedance*, $\hat{Z}$. Thus we can write $\hat{V} = \hat{Z}\hat{I}$. The reason that the engineers like to do this is that they learned something when they were young: $V = RI$ for resistances, when they only knew about resistances and DC. Now they have become more educated and have AC circuits, so they want the equation to look the same. Thus they write $\hat{V} = \hat{Z}\hat{I}$, the only difference being that the resistance is replaced by a more complicated thing, a complex quantity. So they insist that they cannot use what everyone else in the world uses for imaginary numbers, they have to use a j for that; it is a miracle that they did not insist also that the letter Z be an R! (Then they get into trouble when they talk about current densities, for which they also use j. The difficulties of science are to a large extent the difficulties of notations, the units, and all the other artificialities which are invented by man, not by nature.)

Now let us work out what ρ is. If we have a complex number, the square of the magnitude is equal to the number times its complex conjugate; thus

$$\begin{aligned}\rho^2 &= \frac{1}{m^2(\omega_0^2 - \omega^2 + i\gamma\omega)(\omega_0^2 - \omega^2 - i\gamma\omega)}\\ &= \frac{1}{m^2[(\omega_0^2 - \omega^2)^2 + \gamma^2\omega^2]}.\end{aligned} \tag{23.11}$$

In addition, the phase angle θ is easy to find, for if we write

$$1/R = 1/\rho e^{i\theta} = (1/\rho)e^{-i\theta} = m(\omega_0^2 - \omega^2 + i\gamma\omega),$$

we see that

$$\tan\theta = -\gamma\omega/(\omega_0^2 - \omega^2). \tag{23.12}$$

It is minus because $\tan(-\theta) = -\tan\theta$. A negative value for θ results for all ω, and this corresponds to the displacement x lagging the force F.

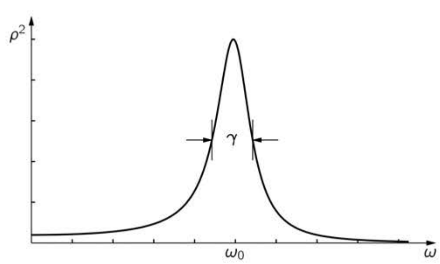


Fig. 23–2. Plot of ρ^2 versus ω.

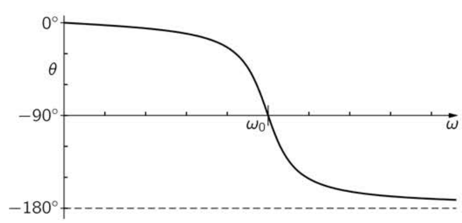


Fig. 23–3. Plot of θ versus ω.

Figure 23–2 shows how ρ^2 varies as a function of frequency (ρ^2 is physically more interesting than ρ, because ρ^2 is proportional to the square of the amplitude, or more or less to the *energy* that is developed in the oscillator by the force). We see that if γ is very small, then $1/(\omega_0^2 - \omega^2)^2$ is the most important term, and the response tries to go up toward infinity when ω equals ω_0. Now the "infinity" is not actually infinite because if $\omega = \omega_0$, then $1/\gamma^2\omega^2$ is still there. The phase shift varies as shown in Fig. 23–3.

In certain circumstances we get a slightly different formula than (23.8), also called a "resonance" formula, and one might think that it represents a different phenomenon, but it does not. The reason is that if γ is very small the most interesting part of the curve is near $\omega = \omega_0$, and we may replace (23.8) by an approximate formula which is very accurate if γ is small and ω is near ω_0. Since $\omega_0^2 - \omega^2 = (\omega_0 - \omega)(\omega_0 + \omega)$, if ω is near ω_0 this is nearly the same as $2\omega_0(\omega_0 - \omega)$ and $\gamma\omega$ is nearly the same as $\gamma\omega_0$. Using these in (23.8), we see that $\omega_0^2 - \omega^2 + i\gamma\omega \approx 2\omega_0(\omega_0 - \omega + i\gamma/2)$, so that

$$\hat{x} \approx \hat{F}/2m\omega_0(\omega_0 - \omega + i\gamma/2) \quad \text{if } \gamma \ll \omega_0 \text{ and } \omega \approx \omega_0. \tag{23.13}$$

It is easy to find the corresponding formula for ρ^2. It is

$$\rho^2 \approx 1/4m^2\omega_0^2[(\omega_0 - \omega)^2 + \gamma^2/4].$$

We shall leave it to the student to show the following: if we call the maximum height of the curve of ρ^2 vs. ω one unit, and we ask for the width $\Delta\omega$ of the curve, at one half the maximum height, the full width at half the maximum height of the curve is $\Delta\omega = \gamma$, supposing that γ is small. The resonance is sharper and sharper as the frictional effects are made smaller and smaller.

As another measure of the width, some people use a quantity Q which is defined as $Q = \omega_0/\gamma$. The narrower the resonance, the higher the Q: $Q = 1000$ means a resonance whose width is only 1000th of the frequency scale. The Q of the resonance curve shown in Fig. 23–2 is 5.

https://www.feynmanlectures.caltech.edu/I_23.html

$$\frac{\tilde{\varepsilon}(\omega, \vec{x})}{\varepsilon_0} \equiv \tilde{\varepsilon}_r(\omega, \vec{x}) = 1 - \frac{\omega_{p(\varepsilon)}^2}{\omega_0^2 - \omega^2 + i\omega\Delta\omega}$$

$$\omega_0^2 = \frac{1}{LC}$$

$$\Delta\omega = \frac{R}{L}$$

$$R = \frac{1}{\pi r^2 \sigma}$$

$$J = \sigma E = \frac{1}{\pi r^2}\frac{dq}{dt} = \frac{1}{\pi r^2} I$$

Parallel plate capacitor C with plate area A, plate separation d and dielectric constant ε in the material between the conducting plates.[31]

$$C = \varepsilon \frac{A}{d}$$

Long inductance coil (solenoid) with n turns per unit length with self-inductance L total length ℓ and radius of single turn ρ.

$$B = \mu n I$$

Magnetic flux is

[31] We will consider a spherical capacitor later.

$$\Phi = B\pi\rho^2 \equiv \frac{L}{N} I = \mu n I \pi \rho^2$$

$$L = \mu n \pi N \rho^2 = \mu n^2 \ell \pi \rho^2 = \frac{\mu N^2 \pi \rho^2}{\ell}$$

$$LC = \frac{\varepsilon \mu N^2 \pi \rho^2 A}{\ell d}$$

We want a very small resonant circuit frequency for warp drive

$$\omega_0^2 = \frac{1}{LC} = \frac{\ell d}{\varepsilon \mu N^2 \pi \rho^2 A} \to 0$$

Define

$$\Sigma \equiv \frac{\ell d}{N^2 \pi \rho^2 A}$$

$$[\Sigma] = \frac{1}{Area}$$

We have the self-consistency condition

$$\omega_0^2 = \frac{\Sigma}{\tilde{\varepsilon}(\omega_0)\tilde{\mu}(\omega_0)}$$

We now have a dilemma because both ε and μ are complex in dissipative dispersive matter. For now, we will take the magnitude not the real part which gives us nothing we can use. Let's for now consider a nonmagnetic dielectric where $\tilde{\mu}(\omega_0) = \mu_0$. I assume

$$\omega_0^2 = \frac{\Sigma}{\mu_0} \frac{1}{|\tilde{\varepsilon}(\omega_0, \vec{x})|}$$

$$\frac{1}{\tilde{\varepsilon}(\omega_0, \vec{x})} = \frac{1}{\tilde{\varepsilon}(\omega_0, \vec{x})_1 - i\frac{\tilde{\sigma}(\omega_0, \vec{x})}{\omega_0}} = \frac{\tilde{\varepsilon}(\omega_0, \vec{x})_1 + i\frac{\tilde{\sigma}(\omega_0, \vec{x})}{\omega_0}}{\tilde{\varepsilon}(\omega_0, \vec{x})_1{}^2 + \left(\frac{\tilde{\sigma}(\omega_0, \vec{x})}{\omega_0}\right)^2}$$

On the other hand, for general ω

$$\tilde{\varepsilon}(\omega, \vec{x})_r \equiv \frac{\tilde{\varepsilon}(\omega, \vec{x})}{\varepsilon_0} = 1 - \frac{\omega_p^2}{\omega_0^2 - \omega^2 + i\omega\Delta\omega} = \frac{\omega_0^2 - \omega_p^2 - \omega^2 + i\omega\Delta\omega}{\omega_0^2 - \omega^2 + i\omega\Delta\omega} =$$
$$= \frac{\left(\omega_0^2 - \omega_p^2 - \omega^2 + i\omega\Delta\omega\right)\left(\omega_0^2 - \omega^2 - i\omega\Delta\omega\right)}{(\omega_0^2 - \omega^2)^2 + (\omega\Delta\omega)^2}$$

Therefore, in the special case at resonance

$$\tilde{\varepsilon}(\omega_0,\vec{x})_r = \frac{\left(-\omega_p^2 + i\omega_0\Delta\omega\right)(-i\omega_0\Delta\omega)}{(\omega_0\Delta\omega)^2} = \frac{\left((\omega_0\Delta\omega)^2 + i\omega_p^2\omega_0\Delta\omega\right)}{(\omega_0\Delta\omega)^2} = 1 + i\,\frac{\omega_p^2}{\omega_0\Delta\omega}$$

However,

$$\tilde{\varepsilon}(\omega_0,\vec{x}) = \tilde{\varepsilon}(\omega_0,\vec{x})_1 - i\,\frac{\sigma(\omega_0,\vec{x})}{\omega_0}$$

Therefore,

$$\tilde{\varepsilon}(\omega_0,\vec{x}) = \varepsilon_0$$

$$\sigma(\omega_0,\vec{x}) = -\varepsilon_0\,\frac{\omega_p^2}{\Delta\omega}$$

$$|\tilde{\varepsilon}(\omega_0,\vec{x})| = \varepsilon_0\sqrt{1 + \left(\frac{\omega_p^2}{\omega_0\Delta\omega}\right)^2}$$

Narrowing of the Resonance Width and Amplification of the Resonance Peak by the Macro-Quantum Coherence

The Heisenberg Uncertainty Principle here is

$$\Delta N\Delta\theta \cong \frac{1}{2}$$

In the Glauber macro-quantum coherent state[32] of a laser beam, a superconductor, a superfluid and a Frohlich condensate, we have Poisson statistics, therefore

$$\Delta N = \sqrt{N}$$

$$\Delta\theta \geq \frac{1}{2\Delta N} = \frac{1}{2\sqrt{N}}$$

$$\Delta\theta = \tau\Delta\omega$$

[32] Minimum uncertainty wave packet in number N and phase θ.

$$\Delta\omega \geq \frac{1}{2\tau\sqrt{N}}$$

The Frohlich condensate effect here is

$$\Delta\omega = \frac{1}{2\sqrt{N_{\omega_0}}\tau}$$

The macroscopic number of bosons in the same resonant mode is

$$N_{\omega_0} \gg 1$$

Therefore, the resonance peak is

$$|\tilde{\varepsilon}(\omega_0, \vec{x})| = \varepsilon_0\sqrt{1 + \left(\frac{2\sqrt{N_{\omega_0}}\tau\omega_p^2}{\omega_0}\right)^2} \to \varepsilon_0\frac{2\sqrt{N_{\omega_0}}\tau\omega_p^2}{\omega_0} \gg 1$$

The self-consistent resonance frequency is

$$\omega_0^2 = \frac{\Sigma}{\mu_0\varepsilon_0\frac{2\sqrt{N_{\omega_0}}\tau\omega_p^2}{\omega_0}} = \frac{\Sigma\omega_0}{2\mu_0\varepsilon_0\sqrt{N_{\omega_0}}\tau\omega_p^2}$$

$$\lim_{N_{\omega_0}\to\infty}\omega_0 = \frac{\Sigma}{2\mu_0\varepsilon_0\sqrt{N_{\omega_0}}\tau\omega_p^2} \to 0$$

Slightly Below or Above Resonance

Recall that for general ω

$$\tilde{\varepsilon}(\omega, \vec{x})_r = \frac{(\omega_0^2 - \omega_p^2 - \omega^2 + i\omega\Delta\omega)(\omega_0^2 - \omega^2 - i\omega\Delta\omega)}{(\omega_0^2 - \omega^2)^2 + (\omega\Delta\omega)^2}$$

Require[33]

$$\omega = \omega_0(1 + \epsilon)$$

$$|\epsilon| \ll 1$$

$$\epsilon\ can\ be\ positive\ and\ negative$$

[33] Do not confuse permittivity ε with the dimensionless parameter ϵ.

$$\omega_0^2 - \omega^2 = (\omega_0 + \omega)(\omega_0 - \omega) \cong -2\omega_0^2\epsilon$$

$$\tilde{\varepsilon}(\omega_0\epsilon, \vec{x})_r = \frac{\left(-2\omega_0^2\epsilon - \omega_p^2 + i\omega_0\Delta\omega\right)(-2\omega_0^2\epsilon - i\omega_0\Delta\omega)}{(2\omega_0^2\epsilon)^2 + (\omega\Delta\omega)^2}$$

$$= \frac{\left(4\omega_0^4\epsilon^2 + 2\omega_p^2\omega_0^2\epsilon + 2\omega_0^3\Delta\omega\epsilon + \omega_0^2\Delta\omega^2\right) + i\left(\omega_0\Delta\omega\omega_p^2 - 2\omega_0^3\Delta\omega\epsilon\right)}{(2\omega_0^2\epsilon)^2 + (\omega_0\Delta\omega)^2}$$

Only keep terms linear in small ϵ

$$\tilde{\varepsilon}(\omega_0, \epsilon, \vec{x})_r \cong$$

$$= \frac{\left(2\omega_p^2\omega_0^2\epsilon + 2\omega_0^3\Delta\omega\epsilon + \omega_0^2\Delta\omega^2\right) + i\left(\omega_0\Delta\omega\omega_p^2 - 2\omega_0^3\Delta\omega\epsilon\right)}{(\omega_0\Delta\omega)^2}$$

$$= \left(1 + \epsilon\left[\left(\frac{\omega_p}{\Delta\omega}\right)^2 + 2\left(\frac{\omega_0}{\Delta\omega}\right)\right]\right) + i\left(\frac{\omega_p^2}{\omega_0\Delta\omega} - 2\frac{\omega_0}{\Delta\omega}\epsilon\right)$$

The magnitude of the relative permittivity resonance peak is

$$|\tilde{\varepsilon}(\omega_0, \epsilon, \vec{x})_r| \cong \sqrt{\left(1 + \epsilon^2\left[\left(\frac{\omega_p}{\Delta\omega}\right)^2 + 2\left(\frac{\omega_0}{\Delta\omega}\right)\right]\right)^2 + \left(\frac{\omega_p^2}{\omega_0\Delta\omega} - 2\frac{\omega_0}{\Delta\omega}\epsilon\right)^2}$$

$$\cong \sqrt{1 + \left(\frac{\omega_p}{\omega_0}\right)^2\left(\frac{\omega_p}{\Delta\omega}\right)^2 - 4\left(\frac{\omega_p}{\Delta\omega}\right)^2\epsilon}$$

$$\cong \left(\frac{\omega_p}{\Delta\omega}\right)\sqrt{\left(\frac{\omega_p}{\omega_0}\right)^2 - 4\epsilon}$$

$$\cong \left(\frac{\omega_p}{\Delta\omega}\right)\left(\frac{\omega_p}{\omega_0}\right)\sqrt{1 - \frac{4\epsilon}{\left(\frac{\omega_p}{\omega_0}\right)^2}}$$

$$\cong \left(\frac{\omega_p}{\Delta\omega}\right)\left(\frac{\omega_p}{\omega_0}\right)\left(1 - \frac{2\epsilon}{\left(\frac{\omega_p}{\omega_0}\right)^2}\right)$$

$$\cong 2\omega_p\sqrt{N_{\omega_0}}\tau\left(\frac{\omega_p}{\omega_0}\right)\left(1-\frac{2\epsilon}{\left(\frac{\omega_p}{\omega_0}\right)^2}\right)$$

The tangent of the phase shift in the complex electric permittivity is

$$tan(arg\tilde{\varepsilon}(\omega_0,\epsilon,\vec{x})_r) = \frac{\left(\frac{\omega_p^2}{\omega_0\Delta\omega}-2\frac{\omega_0}{\Delta\omega}\epsilon\right)}{1+\epsilon\left[\left(\frac{\omega_p}{\Delta\omega}\right)^2+2\left(\frac{\omega_0}{\Delta\omega}\right)\right]}$$

$$\cong \frac{1}{\epsilon}\frac{\left(\frac{\omega_p^2}{\omega_0\Delta\omega}-2\frac{\omega_0}{\Delta\omega}\epsilon\right)}{\left[\left(\frac{\omega_p}{\Delta\omega}\right)^2+2\left(\frac{\omega_0}{\Delta\omega}\right)\right]}$$

$$\cong \frac{\left(\frac{\omega_p^2}{\omega_0}-2\omega_0\epsilon\right)}{2\epsilon\sqrt{N_{\omega_0}}\tau\left[2\omega_p^2\sqrt{N_{\omega_0}}\tau+4\omega_0\right]}$$

Numerical estimate to cancel Earth's surface gravity

$$\vec{g}(0,\vec{x})_i = \frac{d}{2}\pi G\varepsilon_0\mu_0 Re\left\{\left[\left(\frac{\tilde{\varepsilon}(0,\vec{x})}{\varepsilon_0}\right)^2+\left(\frac{\mu_0}{\tilde{\mu}(0,\vec{x})}\right)^2\right]\left[\tilde{\varepsilon}(0,\vec{x})\tilde{E}(0,\vec{x})^2+\frac{\tilde{B}(0,\vec{x})^2}{\tilde{\mu}(0,\vec{x})}\right]\right\}$$

$$\vec{g}(0,\vec{x})_i = \frac{d}{2}\times 3.1\times 6.7\times 10^{-11}\times 8.9\times 10^{-12}\times 4\times 3.1 \times 10^{-7}Re\left\{\left[(\tilde{\varepsilon}(0,\vec{x})_r)^2+\left(\frac{1}{\tilde{\mu}(0,\vec{x})_r}\right)^2\right]\left[8.9\times 10^{-12}\tilde{\varepsilon}(0,\vec{x})_r\tilde{E}(0,\vec{x})^2 + \frac{10^7}{4\times 3.1}\frac{\tilde{B}(0,\vec{x})^2}{\tilde{\mu}(0,\vec{x})_r}\right]\right\}$$

$$\vec{g}(0,\vec{x})_i \cong d\times 10^{-27}Re\left\{\left[(\tilde{\varepsilon}(0,\vec{x})_r)^2+\left(\frac{1}{\tilde{\mu}(0,\vec{x})_r}\right)^2\right]\left[8.9\times 10^{-12}\tilde{\varepsilon}(0,\vec{x})_r\tilde{E}(0,\vec{x})^2 + \frac{10^7}{4\times 3.1}\frac{\tilde{B}(0,\vec{x})^2}{\tilde{\mu}(0,\vec{x})_r}\right]\right\}$$

Look at the dielectric term, let $d = 10^{-2} meters$

$$\vec{g}(0,\vec{x})_i \cong 10^{-40} Re\{[(\tilde{\varepsilon}(0,\vec{x})_r)^3][\tilde{E}(0,\vec{x})^2]\} \approx 10 \frac{meters}{sec^2}$$

Diamond's electric breakdown is $2 \times 10^9 \frac{Volts}{meter}$

So that gives us a factor of 10^{18}

$$\vec{g}(0,\vec{x})_i \cong 10^{-22} Re\{[(\tilde{\varepsilon}(0,\vec{x})_r)^3]\} \approx 10 \frac{meters}{sec^2}$$

$$|\tilde{\varepsilon}(0,\vec{x})_r|^3 \cong 10^{23}$$

$$\tilde{\varepsilon}(0,\vec{x})_r \approx 10^8$$

The resonance in a metamaterial dielectric between the parallel plates of an LCR oscillator circuit obeys a nonlinear self-consistent constraint reminiscent of the equation for the non-perturbative binding energy of a Cooper pair in the BCS model of superconductivity. This implies that as the room temperature macro-quantum coherent Frohlich condensate order parameter amplitude increases that the peak of the resonance in the dielectric relative permittivity increases proportional to the amplitude and both the width of the resonance and the self-consistent resonant frequency decrease toward zero inversely as the coherent order parameter.[34] In addition, I propose a new way of switching between gravity and antigravity in each meta-atom using a second control grid narrow solenoid perpendicular to the circular parallel plates of the capacitor using the Bohm-Aharonov phase shift[xiii] on the Frohlich order parameter permeating the resonating dielectric between the plates.

Metamaterials are structures in which the sizes of the artificial atoms (e.g., quantum dots) and the separation between nearest neighbors in the 2D meta-surface lattice layers are both small compared to the electromagnetic field wave lengths. This is the region where lumped equivalent LCR oscillator circuit models work as good approximations. Similarly, and closely related at the "electron" meta-materials (aka mesoscopic systems) in which the structures are small compared to the electron quantum wavelengths.[35]

"The refractive index of a completely inverted two-level medium … in which the sign of the oscillator strength of the transition is reversed due to the population inversion[36]

---

[34] The complex Frohlich order parameter ψ does at room temperature what the Josephson superconductor order parameter can only do at near absolute zero. $N(\omega)$ below is the 3D volume integral of $\psi^*\psi$ over the support of ψ. For the parallel plate capacitor plate area A plate separation d in homogeneous case $N(\omega) = \psi^*(\omega)\psi(\omega)Ad$

[35] Mesoscopic Physics and Electronics, T. Ando et-al Springer and Physics of Information Technology, N. Gershenfeld, Cambridge.

[36] Population inversion and Superluminality, R. Y. Chiao, p. 97, eqs.(10.5-6) Amazing Light, Springer, 1996

$$n^2(\omega) = 1 - \frac{\omega_p^2}{\omega_0^2 - \omega^2 - i\gamma\omega}$$

$$\omega_p^2 = \frac{4\pi|f|\rho_e e^2}{m}$$

I add the Frohlich condensate effect to Chiao's formula

$$\gamma(\omega) \cong \frac{1}{2\tau\sqrt{N(\omega)}}$$

Again, the Heisenberg Uncertainty Principle here is

$$\Delta N \Delta\theta \cong \frac{1}{2}$$

In the Glauber macro-quantum coherent state[37] of a laser beam, a superconductor, a superfluid and a Frohlich condensate, we have Poisson statistics, therefore

$$\Delta N = \sqrt{N}$$

$$\Delta\theta \geq \frac{1}{2\Delta N} = \frac{1}{2\sqrt{N}}$$

$$\Delta\theta = \tau\gamma$$

$$\gamma \geq \frac{1}{2\tau\sqrt{N}}$$

The Frohlich condensate effect here is

$$\gamma(\omega) = \frac{1}{2\sqrt{N(\omega)}\tau}$$

The macroscopic number of bosonic "plasmons" in the same resonant mode is

$$N_{\omega_0} \gg 1$$

In general, inside matter

---

[37] Minimum uncertainty wave packet in number N and phase θ.
https://en.wikipedia.org/wiki/Coherent_state

$$n^2(\omega) = \varepsilon_r(\omega)\mu_r(\omega)$$

$$n^2(t) = \int \varepsilon_r(t-t')\mu_r(t')\,dt' \sim \int \varepsilon_r(\omega)\mu_r(\omega)\,e^{i\omega t}d\omega$$

In a non-magnetic dielectric

$$\mu_r(\omega) = 1$$

$$\varepsilon(\omega)_r \equiv 1 + \chi_\varepsilon(\omega) = 1 - \frac{\omega_p^2}{\omega_0^2 - \omega^2 - i\gamma\omega}$$

$$\chi_\varepsilon(\omega) = -\frac{\omega_p^2}{\omega_0^2 - \omega^2 - i\gamma\omega}$$

$$\varepsilon(\omega_0)_r \equiv 1 + \chi_\varepsilon(\omega_0) = 1 + i\,\frac{2\sqrt{N(\omega_0)}\tau\omega_p^2}{\omega_0}$$

The resonant dimensionless relative electric permittivity has zero real susceptibility response. Therefore, the imaginary dissipative susceptibility controls the dielectric response of the material to the impressed AC voltage generator pump field at frequency $\omega \to \frac{\omega_0}{2}$ because of the pump nonlinearity in the stress-energy tensor source of the induced warp field giving two responses at $\omega - \omega = 0$ & $\omega + \omega = 2\omega$.

$$\varepsilon(0)_r \equiv 1 + \chi_\varepsilon(0) = 1 - \frac{\omega_p^2}{\omega_0^2}$$

The static DC component relative permittivity goes negative for off mass shell near field virtual plasmon/polariton resonances

$$\varepsilon(0)_r \to -\frac{\omega_p^2}{\omega_0^2}$$

$$\omega_0^2 \ll \omega_p^2$$

The induced repulsive static **anti-gravity blue shift** field scales as

$$-\frac{\omega_p^6}{\omega_0^6} \sim N(\omega_0)^3$$

This could be detectable. As derived in the Appendix

$$\omega_0 \to \frac{\Sigma}{2\varepsilon_0\mu_0\tau\omega_p^2\sqrt{N(\omega_0)}} = \frac{\ell d^{1/2}}{2\pi\varepsilon_0\mu_0\tau\omega_p^2 A^{3/2}\mathrm{N}^2\rho^2|\psi(\omega)|e^{i\left(arg\psi(\omega)+e\int\vec{A}\cdot\vec{dl}\right)}}$$

Note the Bohm-Aharonov phase shift[xiv] must switch discontinuously

$$arg\psi(\omega) + \frac{q}{\hbar}\int\vec{A}\cdot\vec{dl} = 0\ gravity\ or\ \pi\ antigravity$$

The Frohlich macro-quantum coherence amplification effect only comes in the "dissipative" term which becomes laser-like amplification in this case of population inversion of the two-level "qubit" electric dipoles.

$$\varepsilon(\omega)_r = \frac{\omega_0^2-\omega^2-i\gamma\omega}{\omega_0^2-\omega^2-i\gamma\omega} - \frac{\omega_p^2}{\omega_0^2-\omega^2-i\gamma\omega} = \frac{\omega_0^2-\omega^2-\omega_p^2-i\gamma\omega}{\omega_0^2-\omega^2-i\gamma\omega}$$

$$= \frac{\left(\omega_0^2-\omega^2-\omega_p^2-i\gamma\omega\right)(\omega_0^2-\omega^2+i\gamma\omega)}{(\omega_0^2-\omega^2-i\gamma\omega)(\omega_0^2-\omega^2+i\gamma\omega)}$$

$$= \frac{\left(\omega_0^2-\omega^2-\omega_p^2\right)(\omega_0^2-\omega^2)+(\gamma\omega)^2-i\gamma\omega(\omega_0^2-\omega^2)+i\gamma\omega\left(\omega_0^2-\omega^2-\omega_p^2\right)}{(\omega_0^2-\omega^2)^2+(\gamma\omega)^2}$$

$$= \frac{\left(\omega_0^2-\omega^2-\omega_p^2\right)(\omega_0^2-\omega^2)+(\gamma\omega)^2-i\gamma\omega\omega_p^2}{(\omega_0^2-\omega^2)^2+(\gamma\omega)^2}$$

$$tan\big(arg(\varepsilon(\omega)_r)\big) = \frac{\gamma\omega\omega_p^2}{\left(\omega_0^2-\omega^2-\omega_p^2\right)(\omega_0^2-\omega^2)+(\gamma\omega)^2}$$

$$tan\big(arg(\varepsilon(\omega_0)_r)\big) = \frac{\omega_p^2}{\gamma\omega_0} = \frac{2\sqrt{N(\omega_0)}\tau\omega_p^2}{\omega_0}$$

$$tan\big(arg(\varepsilon(0)_r)\big) = 0$$

$$|\varepsilon(\omega)_r|^2 = \frac{\left(\left(\omega_0^2-\omega^2-\omega_p^2\right)(\omega_0^2-\omega^2)+(\gamma\omega)^2\right)^2+\left(\gamma\omega\omega_p^2\right)^2}{((\omega_0^2-\omega^2)^2+(\gamma\omega)^2)^2}$$

$$|\varepsilon(\omega_0)_r|^2 = \frac{((\gamma\omega_0)^2)^2+\left(\gamma\omega_0\omega_p^2\right)^2}{((\gamma\omega_0)^2)^2} = \frac{\gamma^4\omega_0^4+\gamma^2\omega_0^2\omega_p^4}{\gamma^4\omega_0^4} = 1+\frac{\omega_p^4}{\gamma^2\omega_0^2} = 1+\frac{4N(\omega_0)\tau^2\omega_p^4}{\omega_0^2}$$

$$\varepsilon(\omega_0)_r = |\varepsilon(\omega_0)_r|e^{iarg(\varepsilon(\omega_0)_r)} = \sqrt{\left(1+\frac{4N(\omega_0)\tau^2\omega_p^4}{\omega_0^2}\right)}e^{itan^{-1}\left(\frac{2\sqrt{N(\omega_0)}\tau\omega_p^2}{\omega_0}\right)}$$

$$\varepsilon(0)_r = \frac{\left(\omega_0^2-\omega_p^2\right)}{\omega_0^2} = 1-\left(\frac{\omega_p}{\omega_0}\right)^2$$

The static dielectric relative permittivity is real and negative in the near field where the resonance is smaller than the plasma frequency.

$$\varepsilon(\omega_0)_r = \frac{(\gamma\omega_0)^2 - i\gamma\omega_0\omega_p^2}{(\gamma\omega_0)^2} = 1 - i\frac{\omega_p^2}{\gamma\omega_0}$$

Einstein's gravity field equations in the weak field limit in a nonmagnetic metamaterial resonance approximate in a static electric field in a capacitor with oscillating pump voltage $V(\omega_0)$ and plate separation d filled with metamaterial dielectric between the plates

$$G_{00}(\omega_0,\vec{x}) \cong 2\pi G(\varepsilon_0\mu_0)^2\varepsilon_0\left(\frac{4\sqrt{N(\omega_0)}\tau^2\omega_p^4}{\omega_0^2}\right)^3 sin\left(3arctan\left(\frac{2\sqrt{N(\omega_0)}\tau\omega_p^2}{\omega_0}\right)\right)\left(\frac{V\left(\frac{\omega_0}{2}\right)}{d}\right)^2$$

In the quasi-static limit $\omega_0 \to 0$ to cancel Earth's gravity requires in SI/MKS units

$$10^{-22} \cong 2\pi G(\varepsilon_0\mu_0)^2\varepsilon_0\left(\frac{4\sqrt{N(\omega_0)}\tau^2\omega_p^4}{\omega_0^2}\right)^3\left(\frac{V\left(\frac{\omega_0}{2}\right)}{d}\right)^2$$

$$sin\left(3arctan\left(\frac{2\sqrt{N(\omega_0)}\tau\omega_p^2}{\omega_0}\right)\right) = -1$$

To flip the sine from +1 to -1 requires a phase shift

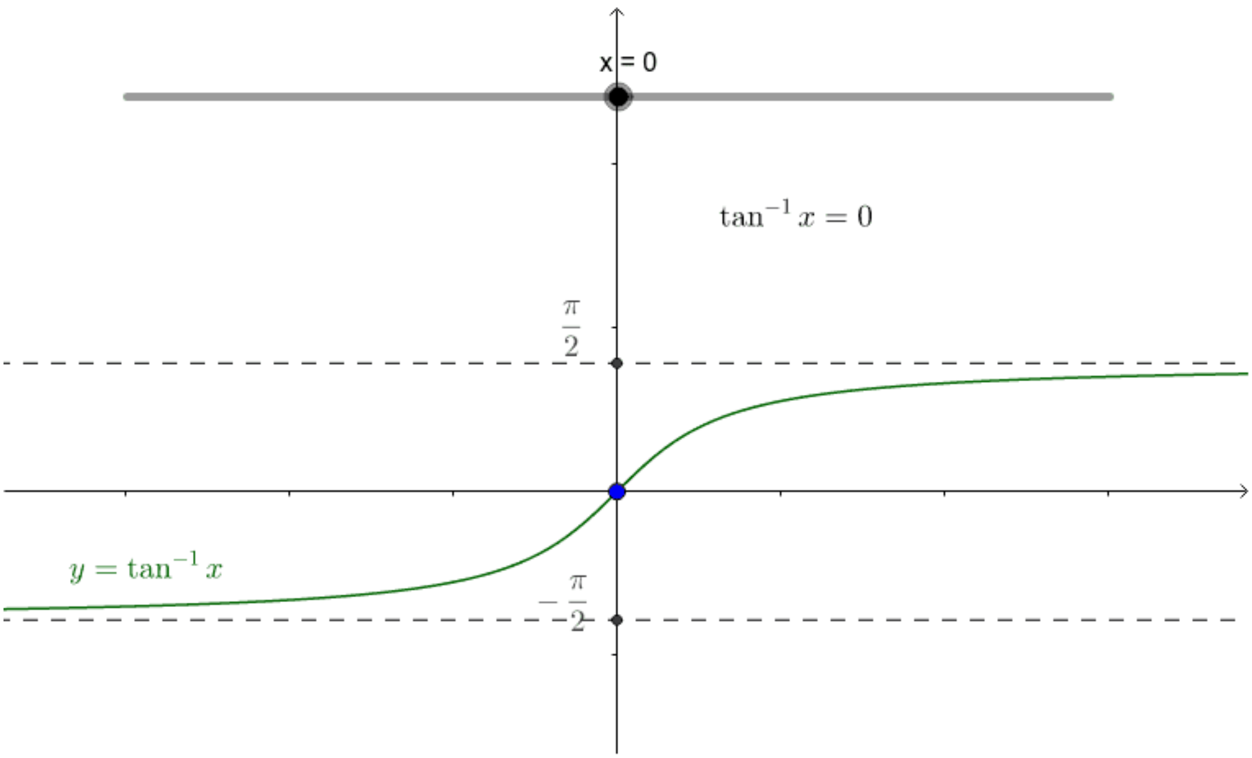
$$x = \frac{2\tau\omega_p^2\psi\sqrt{Ad}}{\omega_0}$$

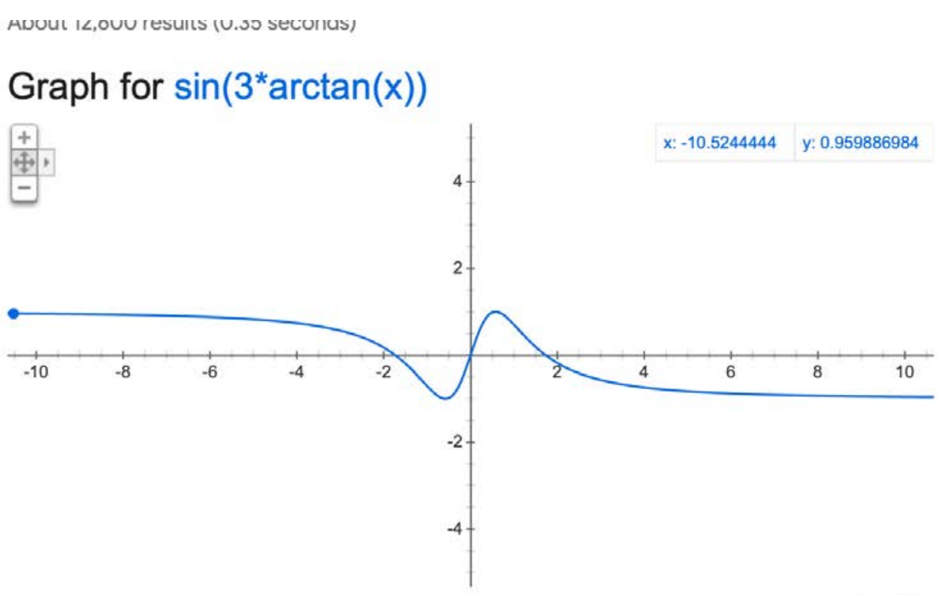
That we control by varying the Frohlich order parameter phase $arg\psi$ between 0 and $\pi.$

$$\psi = |\psi|e^{iarg\psi}$$

$$\sqrt{N} = \psi\sqrt{Ad}$$

Must be real either positive or negative.





$$V(t) = V(\omega) sin(\omega t + \theta)$$

$$V(t)^2 = V(\omega)^2 sin^2(\omega t + \theta)$$

$$sin^2(\omega t + \theta) = \frac{1}{2}\left[cos(0)_{DC} - cos\big(2(\omega t + \theta)\big)_{AC}\right] = \frac{1}{2}\left[1 - cos\big(2(\omega t + \theta)\big)\right]$$

At resonance the applied external pump frequency ω of the voltage generator must be half of the metamaterial resonant frequency ω_0

$$2\omega = \omega_0$$

In SI MKS units

$$G = 6.7 \times 10^{-11}$$
$$\varepsilon_0 = 8.9 \times 10^{-12}$$
$$\mu_0 = 4\pi \times 10^{-7}$$

The six undetermined metamaterial design parameters are $\omega_p, \omega_0, \tau, V(\omega_0), d, N(\omega_0)$.

A more detailed analysis for an LCR oscillator equivalent lumped circuit model shows that the resonance frequency ω_0 is determined self-consistently by a nonlinear constraint in which

$$\lim_{N(\omega_0)\to\infty} \omega_0 = \frac{\Sigma}{2\varepsilon_0\mu_0\tau\omega_p^2\sqrt{\langle N(\omega_0)\rangle}}$$

$$[\Sigma] = \frac{1}{Area}$$

Σ is a pure geometric design parameter for each LCR equivalent circuit depending on the number of turns in the inductance solenoid, the length of the solenoid, the radius of each turn of the solenoid, the area of the capacitor plates and the separation between the plates of the capacitor. Details are in the Appendix.

We need a π phase shift in the Frohlich order parameter to switch between attractive and repulsive gravity in each meta-atom. For example, the DC response is

$$\varepsilon(0)_r = 1 - \left(\frac{\omega_p}{\omega_0}\right)^2 = 1 - N(\omega_0)\left(\frac{2\varepsilon_0\mu_0\tau\omega_p^3}{\Sigma}\right)^2$$

$$N(\omega_0) = |N(\omega_0)|e^{i2arg(N(\omega_0))}$$

Using a solenoid phase modulator narrow coil through the center line of the two circular parallel plates of the capacitor C the required Aharonov-Bohm phase shift is

$$arg\big(N(\omega_0)\big) = \frac{q}{\hbar}\Phi = \mathrm{n}\pi$$

$$n = 0,1,2,3 \ldots$$

Attractive gravity for n even number of quantized magnetic flux quanta, repulsive antigravity for n odd number through the control “grid” solenoid.

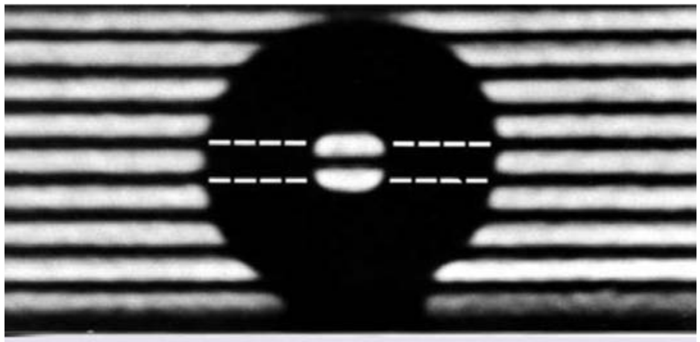
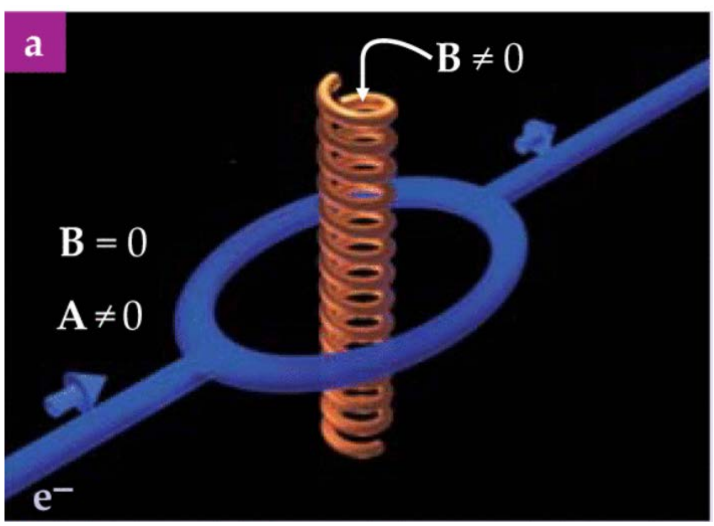


Figure 3. Electron interference pattern demonstrating the magnetic Aharonov–Bohm effect in an experiment that strictly excludes all stray fields.[4] A coherent electron beam traveling normal to the page is made to pass around a toroidal magnet (seen as a shadow) or through its 4-μm-diameter hole. The magnet's superconducting cladding prevents all stray fields. Having threaded or passed around the magnet, the beam is made to interfere with a reference plane wave. The resulting pattern, with the interference fringe inside the hole offset by half a cycle from those outside whenever the magnet flux is an odd multiple of $h/2e$, indicates an AB phase shift of π (modulo 2π) between the threading and bypassing electrons.



https://physicstoday.scitation.org/doi/full/10.1063/1.3226854

$$\varepsilon(0)_r = 1 - \left(\frac{\omega_p}{\omega_0}\right)^2 \to -|N(\omega_0)| e^{i\frac{q}{\hbar}\Phi} \left(\frac{2\varepsilon_0\mu_0\tau\omega_p^3}{\Sigma}\right)^2$$

$$|N(\omega_0)| \gg 1$$

$$\frac{q}{\hbar}\Phi = \mathrm{n}\pi$$

$$\Phi = \iint \vec{B} \cdot d^2\,\vec{x}$$

$$q = effective\ electric\ charge\ of\ the\ Frohlich\ condensate\ order\ parameter$$

$$\nabla^2\phi(0) \sim G\varepsilon_0^3\mu_0^2\varepsilon(0)_r{}^3 \left(\frac{V\left(\frac{\omega_0}{2}\right)}{d}\right)^2 \sim \pm\,|N(\omega_0)|^3$$

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[i] QED Response of the Vacuum

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Abstract: We present a new perspective on the link between quantum electrodynamics (QED) and Maxwell's equations. We demonstrate that the interpretation of the electric displacement vector $D = \varepsilon_0 E$, where E is the electric field vector and ε_0 is the permittivity of the vacuum, as vacuum polarization is consistent with QED. A free electromagnetic field polarizes the vacuum, but the polarization and magnetization currents cancel giving zero source current. The speed of light is a universal constant, while the fine structure constant, which couples the electromagnetic field to matter runs, as it should.

1. Introduction
In quantum electrodynamics (QED) the vacuum is a dynamical entity, in the sense that there are a rich variety of processes that can take place in it [1–3]. There are several observable effects that manifest themselves when the vacuum is perturbed in specific ways: vacuum fluctuations lead to shifts in the energy level of atoms (Lamb shift) [4], changes in the boundary conditions produce particles (dynamical Casimir effect) [5], and accelerated motion and gravitation can create thermal radiation (Unruh [6] and Hawking [7] effects). Free quantum field theories predict the existence of vacuum fluctuations, which are particle-antiparticle pairs that appear spontaneously, violating the conservation of energy according to the Heisenberg uncertainty principle. These fluctuations play a role in the value of the permittivity of the vacuum ε_0: **a photon will interact with those pairs much as it would with atoms or molecules in a dielectric.** This idea can be traced back to the time-honored works of Furry and Oppenheimer [8],Weisskopf and Pauli [9,10] and Dicke [11], who contemplated the prospect of treating the vacuum as a medium with electric and magnetic polarizability. Such a medium may well consist of particle-antiparticle bound states, as first discussed by Ruark [12] and further elaborated by Wheeler [13]. This approach has been recently adopted [14–16] to obtain expressions for the permittivity, leading to ab initio calculations of the value of ε_0 and to useful discussions of the significance of those calculations [17–22]. The main assumption in Refs. [14–16] is to represent the bound states by an effective spring constant, which is taken as the frequency corresponding to an energy $E = mc^2$ (c being the speed of light); that is, twice the rest mass m of the pair. On the other hand, Mainland and Mulligan [23–25] do relate the binding energy of the particle-antiparticle pair to the lowest level of a harmonic oscillator, to give what might be considered to be a true oscillator model.

In the standard relation $D = \varepsilon_0 E+P$, linking the electric displacement vector D and the electric field vector E, the first term on the right-hand side is often referred to as the polarization of the bare vacuum. In QED, however, the polarization due to vacuum fluctuations is added as part of P. Because the new term is dispersionless (like $\varepsilon_0 E$), the electric field can be rescaled to formally recover the initial equation. We suggest that the polarization of the vacuum fluctuations should instead be identified with the first term $\varepsilon_0 E$. This is a paradigm shift in our physical picture of the vacuum. One consequence of this is that in a really bare vacuum, in absence of vacuum fluctuations, the speed of light becomes undefined. Nonetheless, this is only an academic consideration without practical relevance.

We will show that this interpretation of ε_0 is consistent with QED. The vacuum has a crucial property that it does not share with dielectric and magnetic materials: it is Lorentz invariant. Due to this property Michelson and Morley failed to detect the motion of the Earth through the "ether", which, in the present context, is the quantum vacuum[26]. Empty spacetime is homogeneous, so variations of the permittivity ε_0 and permeability m_0 can occur only in the presence of charged matter. The linear response of vacuum must be Lorentz invariant, so in reciprocal space the susceptibility of vacuum must be a function of $k^2 = w^2/c^2 - \mathbf{k}^2$, where w is the photon frequency and k its wave vector. The condition $k^2 = 0$, describing a freely propagating photon, is referred to as on-shellness in QED: a real on-shell photon verifies then $w^2 = \mathbf{k}^2 c^2$.
https://www.mdpi.com/2624-8174/2/1/2

[ii] Tensors are multi-linear frame of reference transformation relative to a reversible mathematical group that has an identity and an inverse for every frame transformation. We only consider physically relevant transformations, not coordinate relabelings, within a fixed frame of reference. Each frame of reference corresponds to a lattice network of identical detectors at rest relative to each other, i.e., fixed space-time intervals among them with local clocks synchronized into the 3D spacelike hypersurfaces of the Arnowitt, Deser, Misner (ADM) foliation. The detectors in a given inertial frame network act as test particles moving on weightless zero G-Force local proper acceleration

timelike geodesics without rotation. The timelike "lapse" function α moves the observer from one spacelike hypersurface to another. The spacelike "shift" 3-vector $\beta_{i=1.2.3}$moves the observer inside the fixed hypersurface.

$$\begin{aligned} ds^2 &= -d\tau^2 = g_{\alpha\beta}\, dx^\alpha\, dx^\beta \\ &= -\left(\alpha^2 - \beta_i \beta^i\right) dt^2 + 2\,\beta_i\, dx^i\, dt + \gamma_{ij}\, dx^i\, dx^j \quad . \end{aligned} \tag{1}$$

https://en.wikipedia.org/wiki/Alcubierre_drive

The above ADM metric (in units with the vacuum inertial frame coordinate speed of light is 1) is completely general for both zero G-Force inertial frames as well as non-zero G-Force non-inertial frames whose detectors move off timelike geodesics because of external electromagnetic forces acting on their charged constituents. This metric form includes time travel to past warp drives, traversable stargates as well as gravity beam tractor, pressor, stressor UFO weapons (Matt Visser) depending on the choices of the lapse and shift fields that I predict can be realized using meta-materials pumped into non-equilibrium Frohlich condensate phases. In the case of light rays,

$$ds^2 = 0$$

Without loss of generality, we can use a 3D space rotation matrix choose a non-inertial frame of reference in which the coordinate speed of light inside a fixed 3D hypersurface Σ_t is

$$\check{c}^i = \left(\frac{dx}{dt}, 0{,}0\right)$$

With shift vector

$$\beta^i = (\beta, 0{,}0)$$

Therefore, restoring the inertial frame vacuum speed of light

$$c^i = \left(\frac{1}{\sqrt{\varepsilon_0 \mu_0}}, 0{,}0\right)$$

$$0 = -\frac{(\alpha^2 - \beta^2)}{\varepsilon_0 \mu_0} dt^2 + \frac{2\beta}{\sqrt{\varepsilon_0 \mu_0}} dx dt + \gamma_{11} dx^2$$

Therefore,

$$0 = -\frac{(\alpha^2 - \beta^2)}{\varepsilon_0 \mu_0} + \frac{2\beta}{\sqrt{\varepsilon_0 \mu_0}} \frac{dx}{dt} + \gamma_{11} \left(\frac{dx}{dt}\right)^2$$

There are generally two distinct magnitudes for coordinate vacuum speeds of light in this non-inertial frame

$$\check{c}_{\pm} = \frac{-\frac{2\beta}{\sqrt{\varepsilon_0\mu_0}} \pm \sqrt{\left(\frac{2\beta}{\sqrt{\varepsilon_0\mu_0}}\right)^2 + 4\gamma_{11}\frac{(\alpha^2-\beta^2)}{\varepsilon_0\mu_0}}}{2\gamma_{11}}$$

$$= \frac{-\left(\beta \pm \sqrt{(\beta)^2 + \gamma_{11}(\alpha^2-\beta^2)}\right)}{\sqrt{\varepsilon_0\mu_0}\gamma_{11}}$$

An example of this is the Sagnac effect for the vacuum coordinate speed of light in rotating non-inertial frames.

In any inertial frame

$$\beta = 0, \alpha = 1, \gamma_{11} = 1$$

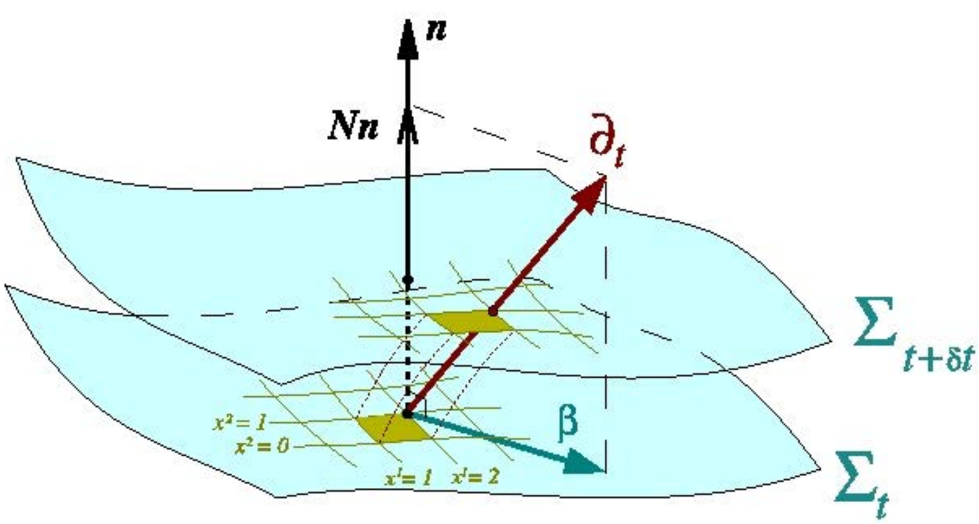
$$\check{c}_{\pm} = \pm\frac{1}{\sqrt{\varepsilon_0\mu_0}}$$

With $\frac{1}{c^2} = \varepsilon_0\mu_0$ invariant under the inertial frame transformations of special relativity, but not invariant under the non-inertial frame transformations of general relativity. However, tensor calculus and the physical principle of covariance requires that the coupling of matter to gravity be generally invariant under all possible frame of reference transformations. It then follows with mathematical certainty that the coupling cannot be

$$8\pi G(\varepsilon_0\mu_0)^2$$

Something is missing.

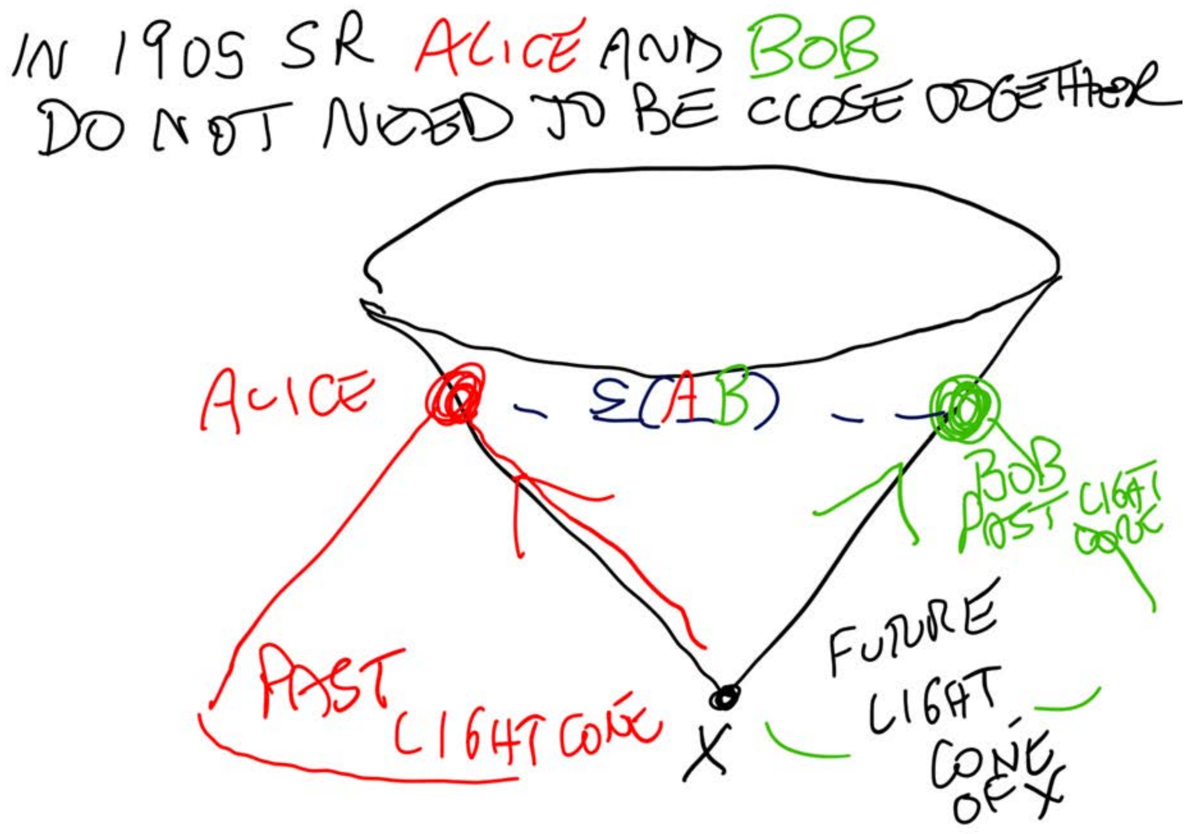
To be continued.



https://arxiv.org/pdf/1103.1220.pdf

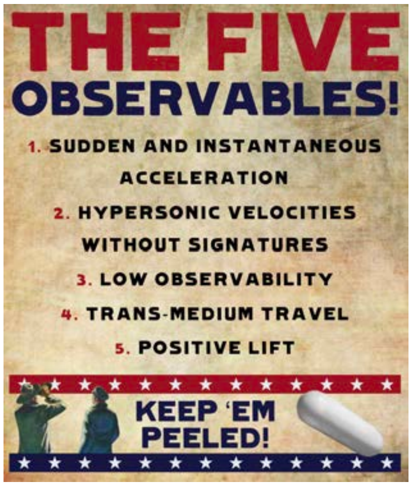
If the space-time is curved, then the size of the network is limited to a 4D spacetime region small compared to the locally variable radii of curvature of the 4th rank Riemann-Christoffel tensor field. There is no such restriction in special relativity which is a global theory that only works in flat Minkowski spacetime which acts on matter without any direct back-reaction of matter on it. The real gravitational field emerges from the direct back-reaction of matter's stress-energy density on the 4D spacetime continuum. The same thing happens in quantum physics. Orthodox quantum physics in the David Bohm interpretation has quantum "active" information pilot fields analogous to the 4D spacetime continuum. In addition, there are the classical level particles (fermions) and fields (boson) in 4D "bulk" (hologram image) that collapse to fractional charge "anyons" with quantum "braid" statistics in 3D "edge" (hologram screen/plate) states in matter as seen in experiments showing Haldane's "Fractional Quantum Hall Effect" that we can do at room temperature using the Frohlich condensate effect (original prediction). Therefore, orthodox quantum physics violates Einstein's meta-physical action-reaction organizing idea in the same way that it does in relativity. Lenny Susskind's QM = GR collapses to non-signaling EPR edge states = non-traversable ER wormhole bulk states with violation of the action-reaction principle as developed by Roderick Sutherland (2015 on arXiv) in a Lagrangian form with local retrocausality in the sense of Yakir Aharonov's Two State Vector (Destiny/History) "weak measurement" theory explaining nonlocal multi-particle EPR quantum entanglement consistent with classical relativity without the need of higher dimensional configuration space-time. Restoring action-reaction then gives EPR signaling edge states = traversable ER wormhole states as I first anticipated in my contribution to the first-edition of Space-Time and Beyond (E.P. Dutton, 1975). I did not at that time have Lenny Susskind's idea that the EPR QM entanglement hologram screen/plate states lived on the "edge" (lower dimensional boundary) of the higher dimensional "bulk" ER wormhole GR classical level states. Lenny, Johnny Glogower, and I worked together at Cornell Fall 1963 and Spring 1964 terms on the problem of time and phase operators in quantum mechanics.

iii



iv Local gauging of the 3D translations corresponds to torsion tensor connection dislocation defects in non-relativistic crystal physics. In contrast, local gauging of the 3D rotation group corresponds to curvature disclination defects (e.g., Hagen Kleinert, Berlin, Germany) with the non-tensor Levi-Civita connection analogue. In the 4D relativistic generalization, the late Waldyr Rodrigues Jr (UNICAMP, Brazil) and independently Gennady Shipov (Moscow, Russia) introduced "teleparallelism" in which the total curvature tensor from both the dislocations and the disclinations cancel out. In this sense, we can consider Einstein's 1916 GR as a local gauge theory of space-time symmetries similar to Maxwell's electrodynamics and the Yang-Mills weak-strong gauge fields for the internal U(1)SU(2)SU(3) symmetries of the standard model of high energy physics with the Higgs scalar field giving inertial rest mass to matter. Note that Einstein's equivalence principle only demands the identity of inertial and passive gravity masses of test particles which are themselves not active mass sources of gravity. This is a violation of action-reaction which is also found in electromagnetic and Yang-Mills field theories.

[v]



[vi] The local *invariance* of the matter-gravity coupling coefficient in Einstein's gravity field equation is in the context of the tensor covariance of the field equation itself. Thus, if Ted and Carol remotely measure tensors and spinors at event X where:

$$X(x_{Ted}) = X(x'_{Carol})$$

$$G_{\mu\nu}\big(X(x_{Ted})\big) = 8\pi \frac{G}{c"\big(X(x_{Ted})\big)^4} S\big(X(x_{Ted})\big) T_{\mu\nu}\big(X(x_{Ted})\big) \;\; Ted's\ equation$$

$$G_{\mu'\nu'}\big(X(x_{Carol})\big) = 8\pi \frac{G}{c"(x_{Carol})^4} S\big(X(x_{Carol})\big) T_{\mu'\nu'}\big(X(x_{Carol})\big) \;\; Carol's\ equation$$

$$G_{\mu\nu}\big(X(x_{Ted})\big) \neq G_{\mu'\nu'}\big(X(x_{Carol})\big)$$
$$T_{\mu\nu}\big(X(x_{Ted})\big) \neq T_{\mu'\nu'}\big(X(x_{Carol})\big)$$
$$c"\big(X(x_{Ted})\big) \neq c"(x_{Carol})$$

$$\frac{S\big(X(x_{Ted})\big)}{c"\big(X(x_{Ted})\big)^4} = \frac{S\big(X(x_{Carol})\big)}{c"(x_{Carol})^4}$$

A zero-rank tensor "scalar field" can vary objectively at different coordinate-independent events

$$X \neq X'$$

While being locally invariant at a fixed X

[vii] Details of the proof that the classical level vacuum phase speed of light is invariant under the inertial frame transformation of Einstein's 1905 Special Relativity

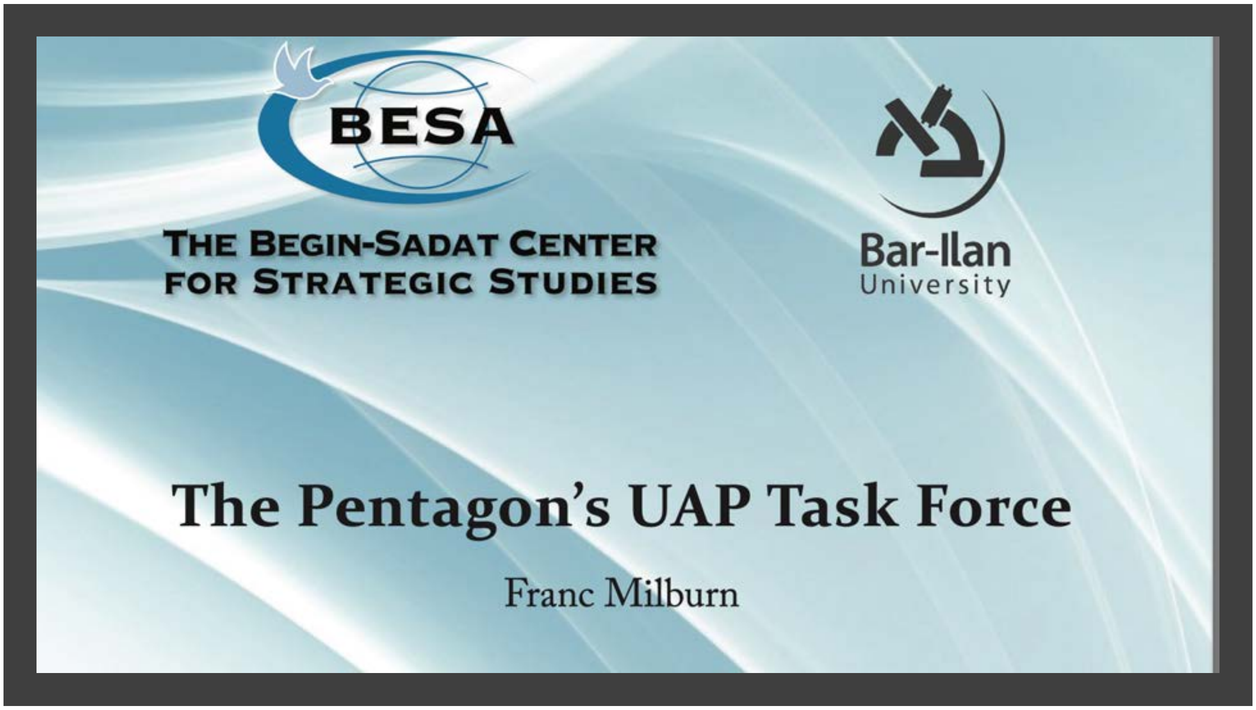
$$ds'^2 \equiv c^2dt'^2 - dx'^2 = c^2\left(\gamma\left(dt - \frac{vdx}{c^2}\right)\right)^2 - \left(\gamma\big((dx - vdt)\big)\right)^2$$
$$= c^2\gamma^2\left(dt - \frac{vdx}{c^2}\right)^2 - \gamma^2(dx - vdt)^2$$
$$= c^2\gamma^2\left(dt^2 + \left(\frac{vdx}{c^2}\right)^2 - 2\frac{vdxdt}{c^2}\right) - \gamma^2(dx^2 + (vdt)^2 - 2vdxdt)$$
$$= \gamma^2\left(c^2dt^2 + \left(\frac{vdx}{c}\right)^2 - 2vdxdt\right) - \gamma^2(dx^2 + (vdt)^2 - 2vdxdt)$$
$$= \gamma^2\left[\left(c^2dt^2 + \left(\frac{vdx}{c}\right)^2\right) - (dx^2 + (vdt)^2)\right]$$
$$= \gamma^2\left[\left(1 - \left(\frac{v}{c}\right)^2\right)c^2dt^2 - \left(1 - \left(\frac{v}{c}\right)^2\right)dx^2\right]$$
$$= \gamma^2\left[\left(\frac{1}{\gamma^2}\right)c^2dt^2 - \left(\frac{1}{\gamma^2}\right)dx^2\right]$$
$$= [c^2dt^2 - dx^2] = ds^2$$

[viii] Quantum field theory distinguishes real from virtual particles. This is explained for example in the Wikipedia article https://en.wikipedia.org/wiki/Virtual_particle

[ix] https://physicsworld.com/a/warm-glow-of-unruh-effect-could-be-seen-in-the-lab-using-accelerated-electrons/
An obscure quantum-mechanical phenomenon involving a warm glow visible only to accelerated observers, long thought almost impossible to detect, should be measurable in the laboratory after all. So, say three physicists in Canada and the US, who reckon that the "Unruh effect" could be seen by accelerating an electron along a very well-defined path while showering it with microwaves. Evidence for the effect, they calculate, should become available after just a few hours of observations – in contrast to the signature from an unirradiated particle, which would take longer than the history of the universe to emerge. The special theory of relativity, which Albert Einstein unveiled back in 1905, applies to observers who are not accelerating – those in "inertial" frames of reference. It tells us that some very unusual effects occur when one observer moves relative to another at close to the speed of light – including the fact that time and velocity are no longer absolute quantities but depend on the observer's frame of reference. However, the theory has little to say about the effects of acceleration.

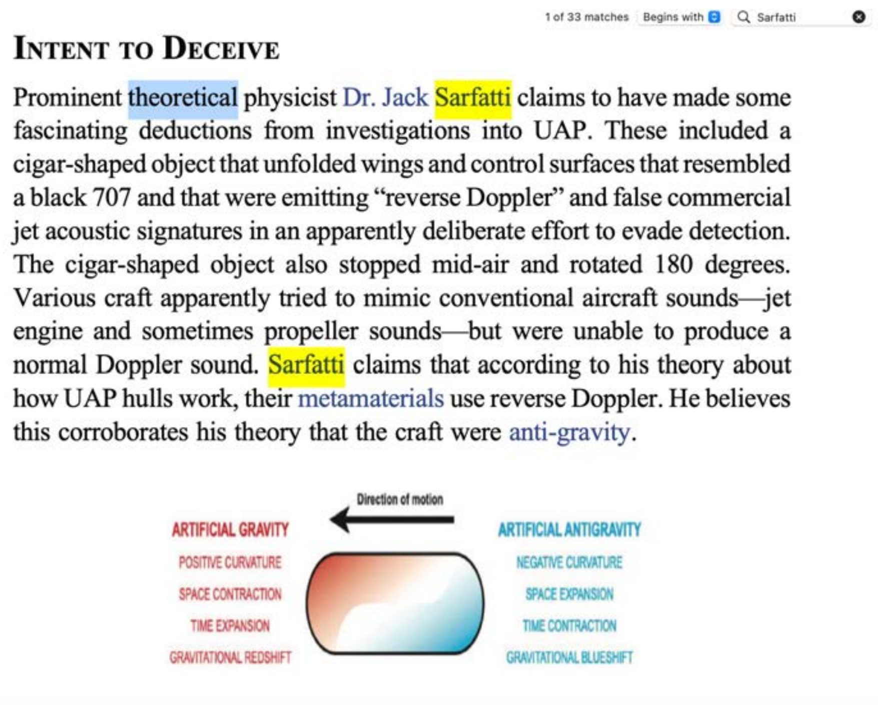
Theorists investigated this problem in the 1970s, seeking to work out what an accelerated observer would experience as they move through the vacuum of deep space. William Unruh, Stephen Fulling and Paul Davies worked out that while an inertial observer would see nothing in particular, the accelerating individual would be basked in a (relatively) warm glow of particles from the quantum vacuum – slightly increasing the temperature in their frame of reference from zero to some finite amount.

x



- Mideast Security and Policy Studies Paper #183
- **EXECUTIVE SUMMARY:** In June 2020, the Senate Select Committee on Intelligence unveiled the Unidentified Aerial Phenomena Task Force (UAPTF) at the Office of Naval Intelligence—a successor to the Advanced Aerospace Threat Identification Program (AATIP). This paper dives down the rabbit hole with Defense Department insiders, scientists, and declassified material to find answers to a host of questions: Are mystery craft near-peer adversary platforms or exotic US platforms? What is the technology behind them? What kind of threat do they pose? What are the geostrategic implications? And what are we not being told?

- https://besacenter.org/uap-task-force/
- https://besacenter.org/wp-content/uploads/2021/03/189WEB-final.pdf

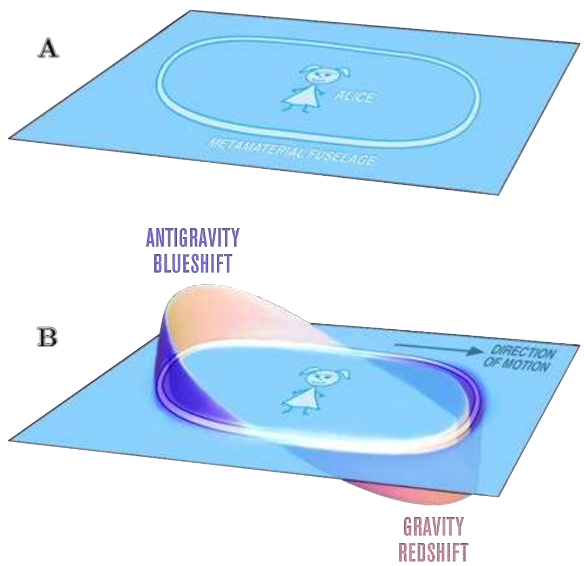


1 of 33 matches Begins with Sarfatti

Intent to Deceive

Prominent theoretical physicist Dr. Jack Sarfatti claims to have made some fascinating deductions from investigations into UAP. These included a cigar-shaped object that unfolded wings and control surfaces that resembled a black 707 and that were emitting "reverse Doppler" and false commercial jet acoustic signatures in an apparently deliberate effort to evade detection. The cigar-shaped object also stopped mid-air and rotated 180 degrees. Various craft apparently tried to mimic conventional aircraft sounds—jet engine and sometimes propeller sounds—but were unable to produce a normal Doppler sound. Sarfatti claims that according to his theory about how UAP hulls work, their metamaterials use reverse Doppler. He believes this corroborates his theory that the craft were anti-gravity.

xi



Julien Geffrey

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xii Extremely long decay time optical cavity

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Abstract: We report on the resonant Fabry Perot cavity of the PVLAS (Polarization of the Vacuum with LASer) experiment operating at ⎣ = 1064 nm with a record decay time of 2.7 ms, a factor more than two larger than any previously reported optical resonator. This corresponds to a coherence length of $8.1 \cdot 10^5$ m. The cavity length is 3.303 m, and the resulting finesse is 770 000.

OCIS codes: (120.2230) Fabry-Perot; (120.3180) Interferometry.

xiii https://journals.aps.org/pr/pdf/10.1103/PhysRev.115.485

PHYSICAL REVIEW

A journal of experimental and theoretical physics established by E. L. Nichols in 1893

SECOND SERIES, VOL. 115, No. 3 AUGUST 1, 1959

Significance of Electromagnetic Potentials in the Quantum Theory

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(Received May 28, 1959; revised manuscript received June 16, 1959)

In this paper, we discuss some interesting properties of the electromagnetic potentials in the quantum domain. We shall show that, contrary to the conclusions of classical mechanics, there exist effects of potentials on charged particles, even in the region where all the fields (and therefore the forces on the particles) vanish. We shall then discuss possible experiments to test these conclusions; and, finally, we shall suggest further possible developments in the interpretation of the potentials.

$$\psi=\psi_0 e^{-iS/\hbar},\quad S=\int V(t)dt,$$

which follows from

$$i\hbar\frac{\partial\psi}{\partial t}=\left(i\hbar\frac{\partial\psi_0}{\partial t}+\psi_0\frac{\partial S}{\partial t}\right)e^{-iS/\hbar}=[H_0+V(t)]\psi=H\psi.$$

The new solution differs from the old one just by a phase factor and this corresponds, of course, to no change in any physical result.

$$\Delta S/\hbar = -\frac{e}{c\hbar}\oint \mathbf{A}\cdot d\mathbf{x},$$

where $\oint \mathbf{A}\cdot d\mathbf{x} = \int \mathbf{H}\cdot d\mathbf{s} = \phi$ (the total magnetic flux inside the circuit).

The phase difference, $(S_1 - S_2)/\hbar$, can also be expressed as the integral $(e/\hbar)\oint \varphi dt$ around a closed circuit in space-time, where φ is evaluated at the place of the center of the wave packet. The relativistic generalization of the above integral is

$$\frac{e}{\hbar}\oint\left(\varphi dt - \frac{\mathbf{A}}{c}\cdot d\mathbf{x}\right),$$

where the path of integration now goes over any closed circuit in space-time.

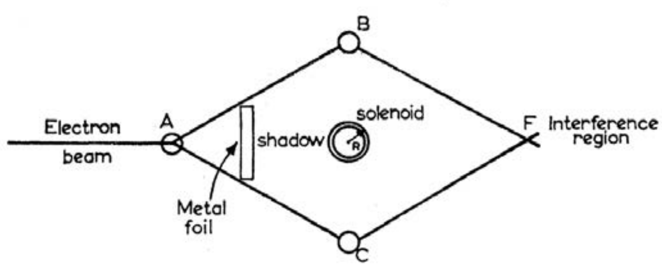


FIG. 2. Schematic experiment to demonstrate interference with time-independent vector potential.

$$\varphi = 2\pi\alpha \equiv -\frac{\Phi}{\Phi_0} = \text{Bohm} - \text{Aharonov phase shift}$$

$$\Phi \equiv \oint \vec{A}\cdot d\vec{x} = \iint \vec{\nabla}\times\vec{A}\cdot d^2\,\vec{x}$$

$$\Phi_0 \equiv \frac{hc}{e} = 4\times 10^{-7} gauss \times cm^2$$

Two kinds of cylindrically symmetrical Bessel J function solutions for the linear Schrodinger equation (extend to Landau-Ginzburg nonlinear equation)

$$\left[\frac{\partial}{\partial r}^2 + \frac{1}{r}\frac{\partial}{\partial r} + \frac{1}{r^2}\left(\frac{\partial}{\partial\theta} + i2\pi\alpha\right)^2 + k^2 + \beta|\psi|^2\right]\psi = 0$$

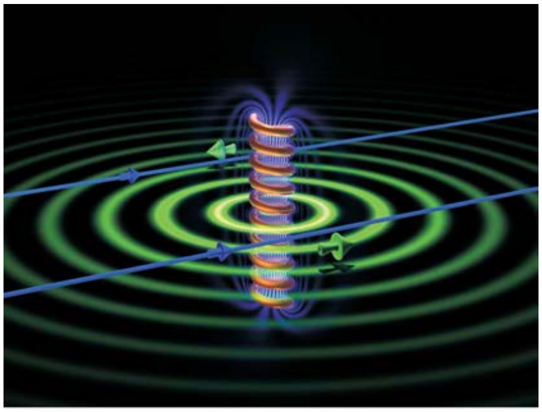
$$\psi = \sum_{m=-\infty}^{+\infty} e^{im\theta}\left[a_m(\beta)J_{m+\alpha}(kr) + b_m(\beta)J_{-(m+\alpha)}(kr)\right]$$

$$r > R = radius\ of\ control\ grid\ solenoid\ phase\ shifter$$

The two kinds of solution are

$$\alpha = n = 0,1,2, \ldots$$
$$\alpha' = n + \frac{1}{2}$$

The induced Bohm-Aharonov phase shift φ between the streamlines $\vec{\nabla} arg\psi$ parallel and anti-parallel to the vector potential $\vec{A}$ **circular pattern** can, in principle, be controlled to be attractive gravity red shift where $\alpha = n$, or repulsive anti-gravity blue shift where $\alpha' = n + \frac{1}{2}$.



[xiv] *Reviews of Modern Physics, Vol. 57, No. 2, April 1985*

The quantum effects of electromagnetic fluxes

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If such effects specific to the quantum nature of the interaction exist, they must depend on the electromagnetic flux, rather than on the local value of the potentials. This circumstance, already mentioned by Franz (1939), was independently discussed by Ehrenberg and Siday (1949), who predicted the existence of observable quantum interference phenomena associated with stationary magnetic fluxes. The full importance of the problem became clear after the detailed description of the quantum effects of the electromagnetic fluxes by Aharonov and Bohm (1959). The action of the enclosed fluxes on the quantum interference of charged particles, known as the Aharonov-Bohm effect, ***produces a shift of the interference fringes relative to the envelope of the pattern, while leaving the envelope unchanged****. Since the observable fringe shifts persist even if the overlap between the incident* *particles and the distribution of electromagnetic flux is rendered arbitrarily small, the existence of the Aharonov-Bohm effect demonstrates that a knowledge of the field strengths in a certain region of the space is not sufficient to characterize completely the state of the electromagnetic continuum in that region.*

After a considerable debate in the literature concerning the physical significance of the Aharonov-Bohm effect, the currently accepted interpretation was proposed by Wu and Yang (1975) in terms of the concept of a nonintegrable phase factor. Thus owing to the action of the electromagnetic flux different physical situations in a region may have the same field strengths, while because of gauge arbitrariness different potentials in a region may describe the same situation. Wu and Yang (1975) stated that the consistent description of the interaction between a particle of charge q and the electromagnetic continuum requires the specification of a certain phase factor R, depending on path integrals of the scalar potential φ and of the vector potential $\mathbf{A}$,

$$R = \exp\left[\frac{iq}{\hbar c}\int (c\varphi\, dt - \mathbf{A}\, d\mathbf{r})\right],$$

so that the electromagnetism is the gauge-invariant manifestation of the nonintegrable phase factor R. While changes in the energy and kinetic momentum of a charged particle depend on the field strengths acting on the particle, it has recently been shown that the nonintegrable phase factor R is measured by changes in the parity of the state of the incident charged particles, due to their interaction with the electromagnetic continuum.

C. Quantum effects of electromagnetic fluxes

In principle, the properties of the electromagnetic field can be determined from the changes in the state of test charged particles interacting with the field. Since the changes in the kinematical state of a charged particle of velocity $\mathbf{v}$ depend on the Lorentz force $q(\mathbf{E}+\mathbf{v}\times\mathbf{B}/c)$, the electromagnetic continuum is described in classical physics by the local values of the electric and magnetic field strengths $\mathbf{E}$ and $\mathbf{B}$. The field strengths are often expressed in terms of the scalar and vector potentials $\varphi, \mathbf{A}$ as

$$\mathbf{E}=-\nabla\varphi-\frac{1}{c}\frac{\partial \mathbf{A}}{\partial t}, \tag{1.34a}$$

$$\mathbf{B}=\nabla\times\mathbf{A}. \tag{1.34b}$$

The distribution of electromagnetic potentials is not uniquely determined by the distribution of field strengths, as a change in the gauge of the potentials

$$\varphi'=\varphi-\frac{1}{c}\frac{\partial f}{\partial t}, \tag{1.35a}$$

$$\mathbf{A}'=\mathbf{A}+\nabla f, \tag{1.35b}$$

leaves the field strengths unaffected, for an arbitrary gauge function f of space and time. Therefore, in classical electromagnetism, the potentials are considered as mathematical entities, without physical significance.

The evolution of the quantum-mechanical state of a charged particle is governed by Eqs. (1.1) and (1.2), which include as field variables the scalar and vector potentials $\varphi, \mathbf{A}$. Therefore it is conceivable that the physical significance of the potentials should eventually become apparent at the quantum-mechanical level of description of the interaction between the charged particles and the electromagnetic field. However, it can be shown by a direct calculation that the change in the gauge of the potentials specified in Eqs. (1.35) implies a phase transformation of the wave function,

A similar effect for magnetic flux can be demonstrated with the aid of an infinitely long solenoid of radius r_0 placed in the shadow of the fiber of the electrostatic biprism, as shown in Fig. 7. In this case, too, the magnetic field does not affect the stationary paths connecting the points in the incidence region to the points in the observing region. However, since the circulation of the vector potential on a loop around the solenoid is equal to the magnetic flux enclosed by that loop, the vector potential has, roughly speaking, opposite orientations on the two sides of the flux region. Then according to Eqs. (1.16) and (1.12), there will be a change in the relative phase of the wave packets arriving in the observing region along different paths, given by

$$\Delta\Phi_B = \frac{q}{\hbar c} \oint \mathbf{A}\mathbf{v}\, dt \ . \tag{1.40}$$

Since $\mathbf{v}\, dt$ is just the differential path element $d\mathbf{r}$, we have

$$\oint \mathbf{A}\mathbf{v}\, dt = \int B\, dx\, dy \ , \tag{1.41}$$

where the integrations are performed, respectively, along the contour formed by the two stationary paths $\tilde{\Gamma}_1, \tilde{\Gamma}_2$ shown in Fig. 7, and on the surface delimited by that contour. Thus

$$\Delta\Phi_B = \frac{\pi q r_0^2 B}{\hbar c} \ , \tag{1.42}$$

so that the magnetic field, although not acting directly on the incident particle, produces a shift of the fringes relative to the envelope of the pattern, which is a periodic function of the amount of enclosed magnetic flux.

It is interesting to compare the effects of uniform electric or magnetic fields, like those considered in the preceding section, with the quantum effects of enclosed electric or magnetic fluxes. We have seen in Sec. I.B that uniform electric or magnetic fields displace an interference pattern as a whole, and moreover, if the slits are symmetric with respect to the incidence direction, the central fringe is bright in the absence as well as in the presence of the fields, as represented in Figs. 8(a) and 8(b). On the other hand, the enclosed fluxes leave the envelope of the interference pattern unchanged, but shift the position of the fringes relative to the envelope of the pattern by a distance depending periodically on the amount of enclosed electromagnetic flux. In particular, whenever the amount of enclosed electric flux $\int E\,dy\,dt$ is an integer multiple of $2\pi\hbar/q$, or the enclosed magnetic flux $\int B\,dx\,dy$ an integer multiple of $2\pi\hbar c/q$, there are no observable changes in the interference pattern, while for half-integer multiples of $2\pi\hbar/q$ or $2\pi\hbar c/q$, respectively, the positions of the light and dark fringes are interchanged, the central fringe becoming dark, as shown in Fig. 8(c). The distinction between the effects of uniform and enclosed fields has been particularly emphasized by Boyer (1973b), and more recently by Greenberger and Overhauser (1979).

F

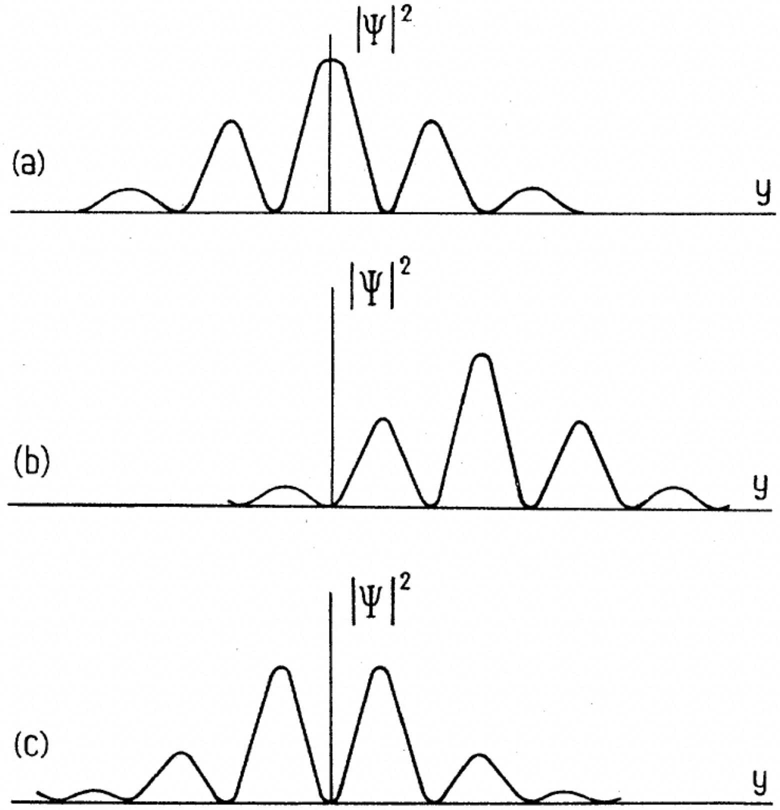


FIG. 8. Effects of various applied electromagnetic fields on the probability distribution in the observing region, for two-slit scattering of charged particles. (a) Unperturbed interference pattern. (b) Pattern displaced as a whole by a uniform electric or magnetic field. (c) Fringe shift produced by an enclosed electric flux of $\pi\hbar/q$ or by an enclosed electric flux of $\pi\hbar c/q$. In this case the position of the light and dark fringes are interchanged with respect to the unperturbed pattern, while the envelope remains unchanged.

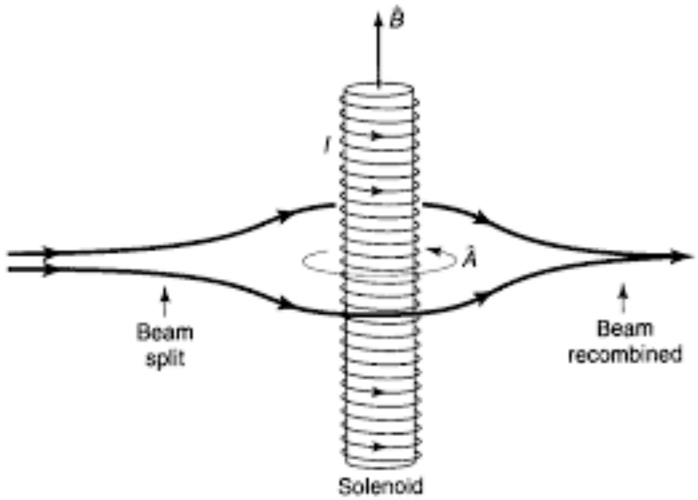
Fig 8 (c) is the π phase shift we need. In the magnetic case from eq. (1.42)

$$\Delta(arg\psi) = \int_{1+}^{2} \vec{\nabla}(arg\psi)\cdot d\overleftrightarrow{\ell} - \int_{1-}^{2} \vec{\nabla}(arg\psi)\cdot d\overleftrightarrow{\ell} = \frac{\pi q r_0^2}{\hbar c} B$$

$$\Delta(arg\psi) = \pi$$

$$1 = \frac{q r_0^2}{\hbar c} B$$

Switches **gravity** to **anti-gravity** provided we can shape the charged Frohlich order parameter streamlines $\vec{\nabla}(arg\psi)$ analogues to charged particle Bohmian trajectories inside the capacitor to correspond to the “double slit” hole topology.



$$i\hbar\frac{\partial\psi}{\partial t} = \alpha\nabla^2\psi + \kappa\psi + \zeta|\psi|^2\psi$$