

Metric Engineering

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under construction

Schwarzschild SSS Exotic Vacuum Solution

The macro-quantum vacuum Einstein field equation is

$$R_{\mu\nu}(x) + \Lambda_{zpf}(x) g_{\mu\nu}(x) = 0 \quad (1.1)$$

Consider the exterior vacuum spherically symmetric static metric with a black hole event horizon

$$ds^2 = -(1 - r_s/r)(cdt)^2 + \frac{dr^2}{1 - \frac{r_s}{r}} + r^2(d\theta^2 + \sin^2\theta d\phi^2) \quad (1.2)$$

Einstein's original 1915 classical geometrodynamics was formulated prior to quantum theory where a localized vacuum spacetime region is not "exotic", i.e. it does not gravitate as "dark matter" with positive micro-quantum zero point pressure, nor does it anti-gravitate as "dark energy" or "exotic matter" with negative micro-quantum zero point pressure. In other words, Einstein's original local classical geometrodynamical field theory is the limit

$$\Lambda_{zpf}(x) = 0 \quad (1.3)$$

The fully covariant equation of state demanded by the Einstein equivalence principle for the micro-quantum zero point vacuum fluctuations of any local quantum field in a curved classical space-time background is

$$\begin{aligned} \rho_{zpf}(x)c^2 + p_{zpf}(x) &= 0 \\ w_{zpf} \equiv \frac{p_{zpf}}{\rho_{zpf}c^2} &= -1 \end{aligned} \quad (1.4)$$

Physical System	w
Zero point vacuum energy density	-1
Galilean matter v/c << 1	0
Electromagnetic radiation	1/3

Note that $w = 1/3$ for real transverse polarized far field photon radiation on the classical light cone gives the famous factor of 2 in the gravity bending of light found by Eddington's expedition to Africa in 1919 that made Einstein really famous.¹

The weak field limit of (1.1) is the Newtonian-Poisson equation for exotic vacuum

$$\nabla^2 U_{zpf}(x) = 8\pi c^2 \Lambda_{zpf}(x) \quad (1.5)$$

where $U_{zpf}(x)$ is the Newtonian scalar potential energy per unit test particle mass of the exotic vacuum volume element at space-time event x . The general equation, in this weak field limit of large local radii of curvature, including any ordinary stress-energy density sources $T_{\mu\nu}(x)$ is

$$\nabla^2 U(x) = -8\pi G \left(\rho + \frac{3p}{c^2} \right) \quad (1.6)$$

Anti-gravitating dark energy exotic vacuum	Gravitating dark matter exotic vacuum
$\Lambda_{zpf} > 0$ negative zero point pressure	$\Lambda_{zpf} < 0$ positive zero point pressure

Imagine a uniform zero point energy density with constant $\Lambda_{zpf} < 0$ spherical source region of dark matter of positive zero point pressure of radius r_{zpf} , therefore

$$r_s = \frac{8\pi}{3} |\Lambda_{zpf}| r_{zpf}^3 \quad (1.7)$$

The net local zero point pressure exotic vacuum scalar field $\sim \Lambda_{zpf}(x)$ is controlled by the local macro-quantum coherent vacuum wave order parameterⁱⁱ $\langle 0 | e^+(x) e^-(x) | 0 \rangle$ emergentⁱⁱⁱ as a spontaneously broken vacuum symmetry induced by the attractive Coulomb BCS pairing of virtual electrons and positrons near the edge of the Fermi-Dirac surface of virtual off-mass shell negative energy electrons. The off-mass shell micro-quantum electron vacuum Fermi energy $E_f(vac) = 0$ is zero with Fermi momentum

$p_f(vac) \sim h/L_p$, where $L_p^2 = hG/c^3 \sim 10^{-66} cm^2$. The center of the Fermi-Dirac electron vacuum volume in the globally flat momentum space of the unstable Minkowski space-time has energy $\sim hc/L_p$ and momentum $\sim hH_0/c$ where $H_0^{-1} \sim 13.7 \times 10^9$ years according to the latest measurements of “precision cosmology.”^{iv} The holographic universe principle suggests that the BCS energy gap of the unstable Dirac-Fermi surface is of order

$$\begin{aligned}
 m_e c^2 &\approx \frac{\alpha hc}{f_e} \sqrt{|\Lambda_{zpf}|} \approx \frac{\alpha hc H_0^{1/3}}{L_p^{2/3} c^{1/3}} \sim \frac{e^2}{1 \text{ fermi}} \sim \frac{\sqrt{\alpha} hc}{L_p} e^{-f_e/\alpha} \\
 10^{-3} &\approx 10^{18} e^{-137 f_e} \\
 10^{-21} &\approx e^{-137 f_e} \\
 21 &\approx \log_e(137 f_e) \approx \log_{10}(44 f_e) \\
 f_e &\sim 0.5
 \end{aligned} \tag{1.8}$$

Where the last term in (1.8) is in Nambu’s and Jona-Lasinio’s notation.^v Note the nonperturbative nonanalytic dependence of the zero point energy induced lepto-quark rest mass on the coupling $\alpha \rightarrow 0$ of the off mass shell virtual electron to the virtual photon, where $\alpha \equiv e^2/\hbar c \sim 1/137$. The seemingly contingent^{vi} physical renormalized self-energy form factor is, for the electron, f_e . Its numeric value depends on the internal distribution and topology of charge density and exotic vacuum zero point energy density in the spatially extended lepto-quarks consistent with J.P. Vigier’s “tight atomic states” model for “cold fusion” exotic atomic energy release. It is of order $1/2$ for the electron and depends on the other internal SU(2) and SU(3) charges. The “Debye energy” of the unstable globally flat “false” micro-quantum vacuum is of the order of the reciprocal Kaluza-Klein compactification scale^{vii}, i.e., $\omega_D \sim \sqrt{\alpha} c/L_p \sim 10^{18} \text{ GeV}/h$. This theory replaces the Haisch-Rueda-Puthoff program of a Lorentz drag force from virtual transverse photon friction on an accelerating massless charge. The latter should only be a small correction to the dark matter cores of all lepto-quarks considered as “hidden variables” in the DeBroglie-Bohm-Vigier-Hiley “quantum realism.” Note that

$$\Lambda_{zpf}(x) = L_p^{-2} \left(1 - L_p^3 \left| \langle 0 | e^+(x) e^-(x) | 0 \rangle \right|^2 \right) \tag{1.9}$$

Einstein’s c-number ODLRO local geometrodynamical field is the strain tensor^{viii}

$$g_{\mu\nu}(x) = \eta_{\mu\nu} + \frac{L_p^2}{2} \left(\frac{\partial}{\partial x^\mu} \frac{\partial}{\partial x^\nu} + \frac{\partial}{\partial x^\nu} \frac{\partial}{\partial x^\mu} \right) \arg \langle 0 | e^+(x) e^-(x) | 0 \rangle \tag{1.10}$$

The torsion form is

$$\tau_{\mu\nu}(x) = \frac{L_p^2}{2} \left(\frac{\partial}{\partial x^\mu} \frac{\partial}{\partial x^\nu} - \frac{\partial}{\partial x^\nu} \frac{\partial}{\partial x^\mu} \right) \arg \langle 0 | e^+(x) e^-(x) | 0 \rangle \quad (1.11)$$

The Diff(4) covariant Landau-Ginzburg BIT FROM IT back-action equation is

$$\langle 0 | e^+(x) e^-(x) | 0 \rangle_{,\mu}{}^{;\mu} + \frac{\delta V(\langle 0 | e^+(x) e^-(x) | 0 \rangle)}{\delta \langle 0 | e^+(x) e^-(x) | 0 \rangle^*} = 0 \quad (1.12)$$

The first term is the curved space-time wave operator^{ix} on the scalar inflation field.^x The second term on the LHS is the functional derivative of the spontaneous broken symmetry effective ODLRO potential. In the simplest case it is a “Mexican Hat Potential.”

Note the world crystal analog of the 3D DeBroglie-Bohm pilot BIT wave guidance of the IT particle “hidden variable” “IT FROM BIT”^{x1} equation

$$\vec{v}(x) = \frac{\hbar}{m} \vec{\nabla} \arg \Psi(x) \quad (1.13)$$

is the 4D world crystal lattice distortion field

$$\begin{aligned} \xi_\mu(x) &= L_p^2 \frac{\partial}{\partial x^\mu} \arg \langle 0 | e^+(x) e^-(x) | 0 \rangle \\ &\equiv L_p^2 \arg \langle 0 | e^+(x) e^-(x) | 0 \rangle_{,\mu} \end{aligned} \quad (1.14)$$

This is consistent with black hole thermodynamics and the world hologram idea that the information in a volume of space is the boundary surface area divided by the Planck area L_p^2 .

Refutation of Hal Puthoff’s PV Program of Metric Engineering I

The idea here is “Einstein’s Vision” as explained by John Archibald Wheeler in his 1950’s book “Geometrodynamics” in which all the “wood” is removed from general relativity using only the “marble” of pure geometry. There is no “matter source” $T_{\mu\nu}(x)$, the spatially extended lepto-quarks are “geons” of “Mass without mass”, “Charge without charge”, “Spin without spin” where the effective gravity coupling on the scale of a Fermi and less obeys

$$\frac{G * m^2}{hc} \sim 1 \quad (1.15)$$

Start with a rough toy model of a spin 0 neutral “geon” with the SSS metric (1.2) and the exotic vacuum dark matter core of (1.7). The Heisenberg uncertainty microscope implies that the scattering probe of this target geon obeys

$$r \sim \frac{h}{p} \quad (1.16)$$

where p is the 3-momentum transfer between probe and target. The event horizon in this particular geon model is when $r_s/r \rightarrow 1$. The apparent target size $\ell_{scattering}$ imaged by the quantum Heisenberg microscope in the scattering is in Einstein’s theory is the classical electron radius multiplied by the ratio of the square root of the surface area dC at the probe scale to the physical radial element dR at the probe scale

$$\ell_{scattering}(p)_{Einstein} \equiv \left(\frac{e^2}{m_e c^2} \right) \left(\frac{dC}{dR} \right) = 2\pi \left(\frac{e^2}{m_e c^2} \right) \sqrt{1 - \frac{r_s p}{h}} \quad (1.17)$$

where the geon looks like a point particle at the event horizon. Ignore issues of Hawking radiation for now. They disappear in the Kerr-Newman case with charge and rotation where the effective surface temperature is zero in a special limit. In contrast, Puthoff’s PV theory in this new microphysics context has

$$\ell_{scattering}(p)_{Puthoff} \equiv 2\pi \left(\frac{e^2}{m_e c^2} \right) e^{r_s p / 2h} \quad (1.18)$$

This gives the wrong answer known from experiment.^{xiii} Puthoff’s theory predicts that the electron’s scattering image should grow larger with shorter distance probes not smaller as is actually observed. Therefore, Puthoff’s PV theory is falsified in Karl Popper’s sense.

Note that

$$m_e = \frac{e^2}{c^2 f_e} \sqrt{|\Lambda_{zpf}|} \quad (1.19)$$

How to picture the electron? It is a small hard massy sphere in Newton’s sense at the classical electron radius of ~ 1 fermi surrounded by a cloud of virtual electron-positron pairs reaching out to the Compton length ~ 100 fermis. However, with deep short distance probes there is enough energy transfer to make some of the virtual electron-positron pairs real and, because of enormous short scale zero point energy induced spatial

micro-curvature, the target lepto-quark itself looks more and more like a point particle when $pc > 2m_e c^2$.

Adding electric charge does not change much. Balancing the exotic vacuum “dark matter core” strong attractive spatial curvature induced by zero point vacuum fluctuations against the repulsion of the electric charge self energy gives the Blackett equation

$$G^* m^2 = \frac{e^2}{f_e} \quad (1.20)$$

The Reissner-Nordstrom warp factor is then

$$1 - \frac{r_s}{r} + \left(\frac{r_e}{r}\right)^2 \rightarrow 1 - \frac{2p}{\sqrt{|\Lambda_{zpf}|} h} + f_e^{-2} \left(\frac{p}{\sqrt{|\Lambda_{zpf}|} h}\right)^2 \quad (1.21)$$

To be continued.

ⁱ Eddington's data was not that good really, but later experiments have confirmed that Einstein was right.

ⁱⁱ This is the Gorkov pair ODLRO parameter from BCS type theories where the e^+ and e^- second quantized fermion field operators destroy positrons and electrons respectively. This local macro-quantum order parameter allows "signal nonlocality" in violation of the sub-quantal "heat death" (Antony Valentini) of micro-quantum theory. It is a complex scalar field under Diff(4) whose phase is the "Goldstone phase" and whose amplitude is the "Higgs field."

ⁱⁱⁱ As in P.W. Anderson's "More is different" principle.

^{iv} Physics Today, April 2003, articles by Michael Turner, Bertram Schwarzschild and Saul Perlmutter

^v "Broken Symmetry: Selected Papers of Y. Nambu" World Scientific, p. 128 "eq. 1.4"

^{vi} In the sense of Max Tegmark's "Parallel Universes" of May 2003 Scientific American in which the weak Anthropic Principle's generalized Darwinian natural selection chooses Martin Harwit's "Six Numbers" to allow our form of carbon-based life with self-awareness to come into being and becoming.

^{vii} Curled up in the 4th space dimension of a 5D hyper space-time.

^{viii} Hagen Kleinert's 4D "world crystal lattice" formalism with curvature as disclination defect density of Goldstone-Berry phase singularities, and torsion as dislocation defect densities. Here I assume no external EM fields, which would require using U(1) gauge invariant partial derivatives like in the Bohm-Aharonov and Josephson effects.

^{ix} A comma means ordinary partial derivative. A semi-colon means the Diff(4) covariant derivative with the Levi-Civita Christoffel connection field for parallel transport of tensor fields along vector fields in the curved manifold of the spacetime tangent bundle.

^x There is a scale L dependence I suppress here for simplicity. We need to use a wavelet transform generalization of the Fourier transform based Wigner phase space density modified for macro-quantum ODLRO in the reduced micro-quantum density matrices as shown by Oliver Penrose. Inflationary cosmology is when the scale $L > 10$ megaparsecs at the current epoch in our expanding accelerating local Hubble past light cone universe that is a parallel universe at Level 1 in Max Tegmark's classification in May 2003 Scientific American.

^{xi} John Archibald Wheeler's phrase on how matter-geometry emerges from non-classical information – The World Made Flesh. Here we have a "two way relationship" (Bohm and Hiley "The Undivided Universe") between IT (hidden variable) system point and BIT information pilot wave landscape.

IT FROM BIT + BIT FROM IT = UNIVERSE AS A SELF-EXCITED CIRCUIT

^{xiii} My "back of the envelope" heuristic estimate of the prediction for Puthoff's model is based on transforming the isotropic radial coordinate back to the Schwarzschild radial curvature coordinate. The latter is defined as the square root of the physical closed spherical boundary mod 4π . Puthoff disputes this step and we disagree here as a matter of principle. Puthoff wishes to treat the isotropic coordinate as a curvature coordinate, which definitely conflicts with Einstein's ideas.