Solid State Physics and General Relativity
The Cipher of Genesis for the Birth of Spacetime
http://www.ibiblio.org/wm/paint/auth/botticelli/venus/venus.jpg
By
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Kleinert's "World Crystal Lattice"

A purely classical solid state 4-dimensional Minkowski signature "world crystal" reformulation of Einstein's 1915 geometrodynamics generalized to include torsion can be found in links on Hagen Kleinert's homepage, http://www.physik.fu-berlin.de/~kleinert/ I have added a Bohmian quantum realist[1] substratum to what Kleinert started in http://stardrive.org/Jack/Casimir.pdf .

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[1] The Bohr-Heisenberg idea of quantum reality is purely idealistic, i.e. "thought like" qubit waves in configuration space for entangled systems in Henry Stapp's sense from his book "Mind, Matter and Quantum Mechanics". Bohm's dualistic realism has both "thought like" and "rock like" (Stapp) pieces of equal fundamental ontological standing. There is no miraculous (Bohr as the second Hans Christian Anderson) Copenhagen Fairy Tale Magic Puff "The Smoky Dragon" in a "ex Deux Machina "collapse" of a thought like qubit wave into a rock like material particle, or classical electromagnetic field configuration, or classical Einstein spacetime geometry as the case may be. Likewise, there is no stand alone purely thought like intrinsically mental Deutschean "multiverse" ("Fabric of Reality") as in the original, really "many minds", formulation started by Hugh Everett. David Deutsch does introduce the over kill "excess metaphysical baggage" (Wheeler) of material "shadow" particles, even "shadow people" and "shadow worlds" where only one is really needed. True, the many "O Brane New Worlds" of "hyperspace" (Stephen Hawking's "The Universe in a Nutshell", Michio Kaku's "Hyperspace" and "The Universe's Unseen Dimensions", Aug 2000 Scientific American, gives a topologically rich set of parallel material worlds connected together by star gate time machines -- Hawking's "chronology protection conjecture" be damned. This tangled material network of Einstein classical spacelike (3+ ?)-dim geometrodynamic field configurations flows on the intrinsically mental physically real qubit Deutsch multiverse that is its landscape in the sense of spontaneously self-organizing complexity theory (Stuart Kauffman's "At Home In The Universe"). What is needed is Escher's "Drawing Hands" http://www.worldofescher.com/gallery/DrawingHandsLg.html i.e. a "two way relation" or "strange loop" (Doug Hofstatder) between the mental quantum landscape and the material many brane network to form the spontaneous conscious "Super Cosmos" what Sir Fred Hoyle called "The Intelligent Universe". Orthodox quantum theory is "one-way" with "signal locality" (AKA Abner Shimony's "passion at a distance") from a "fragile" quantum potential (p. 30 & Ch. 14 "The Undivided Universe", David Bohm and Basil Hiley) made "robust" with "backaction" in presence of a Bose-Einstein condensate in an open system pumped far from sub-quantal thermodynamic equilibrium. Note: "SUBQUANTUM INFORMATION AND COMPUTATION" by Antony Valentini who wrote:
"It is argued that immense resources - for nonlocal communication, espionage, and parallel computation - are hidden from us by a veil of quantum noise that is not fundamental, but merely reflects the statistical properties of an equilibrium state in which the universe happens to be at the present time. It is suggested that "non-quantum" or nonequilibrium matter might exist today in the form of relic particles from the early universe. We describe how such matter could be detected and put to practical use, for superluminal signalling, for eavesdropping on quantum key distribution, and for reading all the results of a parallel

Andre Sakharov's 1967 Problem

The new idea is that classical spacetime comes into being from a spontaneous broken continuous symmetry in a primordial unstable wannabe *antigravitating* vacuum. This vacuum is for a *globally flat* Einstein-Minkowski 4-dimensional spacetime X with the usual completely random *locally uncontrollable* zero point fluctuations of all the renormalizable gauge force and source fields. The spontaneous phase transition is to a *lower* energy density *macroscopic* quantum phase coherent vacuum characterized by a *virtual* Bose-Einstein condensate, which as for real superfluid helium and real electrical superconductors, has a *scale-dependent* single component "spin 0" complex number order $U(1)$ parameter $\Psi(X,K)^2$ made from mainly virtual (off mass shell) spin singlet electron-positron pairs. The 4-wave number is $K \approx 1/L$ where L is the scale of *coarse-graining* integrating out high frequency short wave modes that are below the resolution of the detectors. These virtual pairs macroscopically occupy the same center of mass wave packet $\Psi(X,K)$. The relative coordinate in the center of mass X frame of the virtual particle-antiparticle pair is χ. Einstein's classical curved spacetime geometrodynamic field $g_{\mu\nu}(X,K)$ is then the strain tensor of the Kleinert "world crystal" infinitesimal distortion field $\xi_\mu(X,K)$ that, in turn, comes from the Josephson gauge covariant modulation of the phase $\arg \Psi(X,K)$ in which the usual parameter $\hbar/m$ is replaced by the quantum gravity Planck area Bekenstein c-bit L_p^2. The all-important locally variable quintessent field $\Lambda(X,K)$ comes from the complementary modulation of $|\Psi(X,K)|$. The ordinary classical vacuum of Einstein's 1915 general theory of relativity is the limiting case $\Lambda(X,K) \to 0$ in which a constant quintessent field at large scales $K \to 1/(Hubble-radius)$ is the "cosmological constant". It is the derandomizing cohering of the gauge field zero point fluctuations, sending the corresponding Debye-Waller factor of the Kleinert "world crystal" to 1[3], in the spontaneous broken symmetry primordial quantum vacuum phase transition that explains why the cosmological constant is so small on the average at large scales. Due to the peculiar nature of the equation of state of quantum zero point fluctuations when combined with Einstein's local "free float" principle of equivalence[4], $\Lambda(X,K) > 0$ is precisely Kip Thorne's antigravitating exotic matter of negative active gravity mass density from the pressure term in general relativity

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quantum computation." http://lanl.arxiv.org/abs/quant-ph/0203049 See also Martin Gardner's "Magic and Paraphysics" in "Science, Good, Bad and Bogus" as well as http://stardrive.org/Jack/cover.jpg in press.

[2] In accord with renormalization group ideas in the background, the Wigner phase space density formalism generalizing the quantum reduced density matrix formalism in configuration space for entangled qubits, is introduced. The 4- wave vector "K -dependence" is dictated by the finite time and space resolutions of the detectors in coarse graining, i.e. integrating out Fourier components of signals from measurements that are not in the response window of the detectors. In general one must integrate out both high and low K components, i.e. use K and dK (bandwidth). However, the dK notation is suppressed here for simplicity.

[3] The Bohmian subquantum and thermal fluctuations are closely related here. Driving the system off equilibrium applies at both thermodynamic and "subquantum" levels in Valentini's sense – is my conjecture here.

[4] John Archibald Wheeler, "A Journey into Gravity and Spacetime", Scientific American Press.

that is needed to keep traversable wormholes open and also to realize Alcubierre's free float "warp drive" on shorter scales and is the cause of the acceleration of the expanding universe on the cosmological scale. $\Lambda(X,K) < 0$ is the "dark energy" missing mass of the universe on shorter scales. Light emitted by a real electron in an exotic vacuum region will be blue shifted when detected in our ordinary vacuum. Similarly, light emitted by a real electron in a "dark energy" vacuum region will appear red shifted. This may explain gamma ray bursts and anomalous red shifts associated with quasars. I suppress the explicit scale K dependence in the equations that follow to keep the notation simple. However, the underlying scale dependence should be kept in mind. Einstein's local geometrodynamic field equation with the macroscopic quantum vacuum correction is

$$G_{\mu\nu}(X) + \Lambda(X)g_{\mu\nu}(X) = -8\pi \frac{G}{c^4} T_{\mu\nu}(X) \tag{1.1}$$

The connection of the local quintessent field to the virtual Bose-Einstein condensate's local order parameter with long-range quantum phase coherence is

$$\Lambda(X) = \frac{1}{L_p^2}\left[1 - L_p^3 |\Psi(X)|^2\right] = \frac{1}{L_p^2}\left[1 - L_p^3 \rho_s(X)\right] \tag{1.2}$$

The nonrandom cohered zero point Bose-Einstein condensate "superfluid" number density is

$$\rho_s(X) = \frac{1}{L_p^3}\left[1 - L_p^2 \Lambda(X)\right] = \rho - \rho_n(X) \tag{1.3}$$

The random incoherent zero point "normal fluid" number density of the quantum vacuum is

$$\rho_n(X) = \frac{\Lambda(X)}{L_p} \equiv \frac{\rho(ZPF)}{m_p} \tag{1.4}$$

This quantum "normal fluid" vacuum density is negative[5] for the anomalously gravitating missing mass of the universe. This is more *macroscopic quantum weirdness* like the *negative* regions of the quantum *Wigner phase space density*, in fact this *is* a Wigner phase space density when we put the scale dependence back in explicitly i.e.

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[5] This "dark energy" regime gives anomalous redshifts if accelerating charges move through this newly predicted quantum vacuum phase, which has more than 10^{99} virtual electron-positron pairs per cc in the local Bose-Einstein condensate. Our ordinary vacuum has zero normal fluid density at large scales. The scale dependence is important as Casimir force experiments show significant normal fluid density at micro to nanometer scales for K. What is of immediate laboratory interest is the K scale dependent generalized Fourier transform of the local quintessent field.

$$\rho_n(X) \to \rho_n(X,K)$$
$$-\infty < \rho_n(X,K) < +\infty$$

(1.5)

The total number density of the antigravitating globally flat completely locally random zero point fluctuating false vacuum of Haisch, Rueda and Puthoff's "SED" model is

$$\rho_n(\max) = \rho = \frac{1}{L_p^3} > 0$$

(1.6)

The effective weak curvature Poisson equation of the quantum vacuum stuff from the active gravity mass density $\rho + 3p/c^2$ with the zero point equation of state

$$\rho(ZPF) + \frac{p(ZPF)}{c^2} = 0$$

(1.7)

is

$$\nabla^2 V(ZPF) \approx -4\pi G \left[\rho(ZPF) + \frac{3p(ZPF)}{c^2} \right]$$
$$= 8\pi G\rho(ZPF) = 8\pi Gm_p \rho_n(X) = 8\pi Gm_p \frac{\Lambda(X)}{L_p} = 8\pi c^2 \Lambda(X)$$

(1.8)

The net gravitation or antigravitation of a space region of quantum vacuum depends upon how much "normal fluid" density ρ_n there is. This *locally random* "virtual noise" density component must be *negative* to *gravitate* as *dark matter*. It requires a great deal of *locally nonrandom* coherent "signal" superfluid density to force the *virtual* normal fluid density negative! This has not been realized by Haisch, Rueda, Puthoff and others who tear their hair out over the mystery of the cosmological constant's connection to quantum zero point energy.
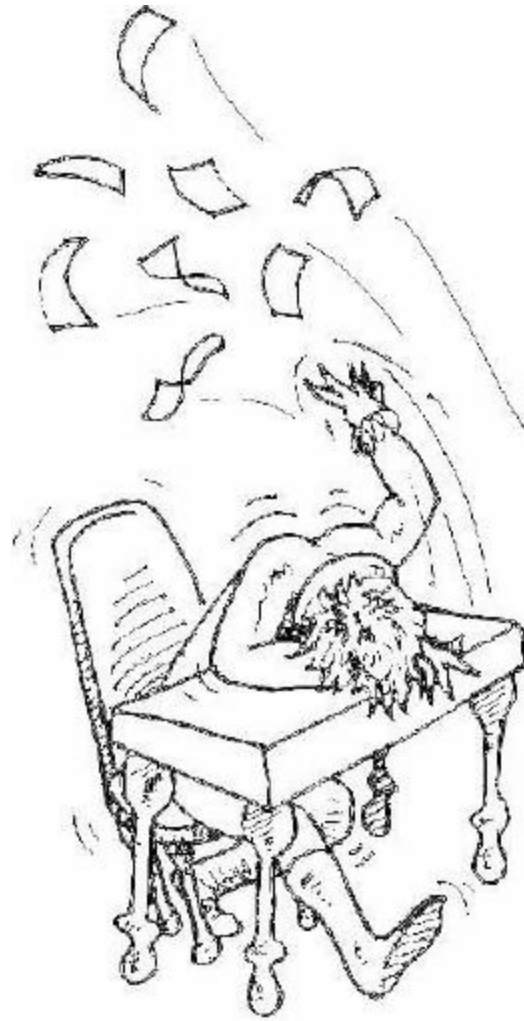
THE BREAKDOWN
OF CLASSICAL PHYSICS

The classical curved spacetime metric tensor (AKA Einstein's local geometrodynamical field) is from the 4-dim "elastic" Kleinert world crystal analog of the 3-dim de Broglie-Bohm-Josephson "phase lock" equation for the Bohm "hidden variable" particle "system point" surfing on the qubit pilot wave "landscape".

$$\vec{v}_s = \frac{\hbar}{m}\vec{\nabla}\arg\psi - \frac{e}{mc}\vec{A} \qquad (1.9)$$

$$\frac{\hbar}{m} \to L_p^2 \qquad (1.10)$$

$$g_{\mu\nu}(X) \approx \frac{1}{2} L_p^2 \left(\bar{D}_\mu(X) \bar{D}_\nu(X) + \bar{D}_\nu(X) \bar{D}_\mu(X) \right) \arg \Psi(X) \tag{1.11}$$

$$L_p^2 \equiv \frac{\hbar G}{c^3} \tag{1.12}$$

The total spin singlet charge neutral virtual electron-positron pair wave function that is macroscopically occupied in the $\Psi(X)$ factor below is

$$\psi(x',x) = \psi'(X,\chi) = \Psi(X)\psi(\chi) = |\Psi(X)||\psi(\chi)| e^{i[\arg \Psi(X) + \arg \psi(\chi)]} \tag{1.13}$$

The pair configuration space gauge covariant derivative of the phase of the wave packet is

$$\left\{ \bar{D}_\mu(x) + \bar{D}_\mu(x') \right\} \arg \psi'(x,x') \rightarrow \left\{ \bar{D}_\mu\left(X + \frac{\chi}{2}\right) + \bar{D}_\mu\left(X - \frac{\chi}{2}\right) \right\} \left[\arg \Psi(X) + \arg \psi(\chi) \right]$$

$$= \left\{ \frac{\partial}{\partial X^\mu} - \frac{e}{\hbar c} \left[A_\mu\left(X + \frac{\chi}{2}\right) + A_\mu\left(X - \frac{\chi}{2}\right) \right] \right\} \left[\arg \Psi(X) + \arg \psi(\chi) \right] \tag{1.14}$$

$$\bar{D}_\mu(X) \arg \Psi(X)$$

$$\equiv \left\{ \frac{\partial}{\partial X^\mu} - \frac{e}{\hbar c} \int d^4\chi \left[A_\mu\left(X + \frac{\chi}{2}\right) + A_\mu\left(X - \frac{\chi}{2}\right) \right] \right\} \left[\arg \Psi(X) + \arg \psi(\chi) \right] \tag{1.15}$$

$$\approx \left\{ \frac{\partial}{\partial X^\mu} - \frac{2e}{\hbar c} A_\mu(X) \right\} \arg \Psi(X) + multipoles$$

Note that an electron and a positron, initially coincident at rest, flow in opposite space directions in an applied electric field that is suddenly switched on giving a net 3-vector spacelike current density for zero average charge density. In the present case, the particles are all virtual off mass shell.

Topological defects in the macroscopic quantum order parameter space translate into string curvature disclinations and torsion dislocations in the Kleinert classical world crystal lattice with unit cell scale L_p in the long wave limit. I will explore this in more detail in future upgrades. The 4-dimensional world crystal will have smallest volume primitive unit cells with different "crystallographic" symmetries corresponding to different quantum vacuum phases. The repeated identical primitive unit cells form the direct lattice of a perfect crystal. The symmetry of the unit cell is determined by a set of basis vectors $\vec{a}_\mu$. Any lattice point "node" of the direct lattice is

$$\vec{r} = n^\mu \vec{a}_\mu \tag{1.16}$$

$$n^\mu = 0, \pm 1, \pm 2, ...$$

Equivalent points in different unit cells lie in a periodic "Bravais lattice". The Wigner-Seitz unit cell is bounded by *bisecting* planes perpendicular to the basis vectors that can be thought of as emanating from a given lattice node. We start from the globally flat perfect 4-dim world lattice. Therefore, we can use Fourier analysis and define the dual reciprocal lattice in momentum or wave number space. The smallest Wigner-Seitz cell for the reciprocal lattice is the "first Brillouin zone". If there are N unit cells in the direct lattice of globally flat spacetime then the reciprocal lattice has N lattice points inside the first Brillouin zone. Discrete point groups of the unit cell that are compatible with the periodic translational symmetry of the lattice are called "crystallographic point groups". These groups depend on the number of different possible Bravais lattices. For example, the two dimensional Euclidean plane with $\vec{a}_1, \vec{a}_2$ has 5 Bravais lattice possibilities

- Square
- Oblique
- Rectangular
- Centered rectangular
- Hexagonal

Naïve 5-fold symmetry in the plane is impossible neglecting the Penrose tiling of "quasicrystals". There are 14 distinct Bravais lattices in Euclidean 3-space
- Simple cubic
- Body-centered cubic
- Face-centered cubic
- Tetragonal (2 kinds)
- Orthorhombic (4 kinds)
- Monoclinic (2 kinds)
- Trigonal
- Trigonal and hexagonal
- Triclinic

How many Bravais lattices are in the Kleinert Minkowski world crystal? Note the lengths of the basis vectors matters. They cannot all be L_p in length exactly. Space-time orientation is velocity of course in addition of space-space orientations.

Quantum Loophole in Second Law of Thermodynamics

A note on the meaning of temperature, energy and information in open systems held far from thermodynamic equilibrium.

Recall

$$dS = \frac{dQ}{T} \qquad (2.1)$$

Temperature of random heat is essentially for a closed system

$$T_{closed} = \frac{dQ_{random-heat}}{dS_{c-bits}} \tag{2.2}$$

That is the ordinary classical thermodynamic temperature of hot matter and radiation in a quasi-closed system is the rate of change of the random internal energy with entropy or c-bit information. In classical kinetic theory of ideal gases, temperature is a measure of random kinetic energy of "molecular chaos" and it must be positive. This random classical measure of temperature is not complete in the quantum realm where we can have negative temperatures from (2.2) due to quantization of energy of microscopic states. For example, in a system of N spins, or generally strings of N qubits in a "quantum computer". The Carnot efficiency of a reversible thermal engine is by the second law of thermodynamics

$$\xi = \frac{W}{Q_{hot}} = \frac{Q_{hot} - Q_{cold}}{Q_{hot}} = 1 - \frac{T_{cold}}{T_{hot}} \tag{2.3}$$

However, in quantum physics, any negative temperature is hotter than any positive temperature. Therefore, we can, in principle, have Carnot efficiencies greater than 100% in which heat flows from both hot and cold reservoirs are completely converted to useful work W. This is not a violation of the second law of thermodynamics as it first appears. To the contrary it is a consequence of the classical second law of thermodynamics combined with the quantum principle to give still another weird counterintuitive result.

The Frohlich Conjecture for Open Systems

The Frohlich Ansatz from a toy model of an electric dipole biomembrane is that an open system has an effective coherence temperature

$$T_{open} \overset{?}{\sim} \frac{1}{\left(\dfrac{dE}{dt}\right)} \equiv \frac{\Xi}{\left(\dfrac{dE}{dt}\right)} \tag{2.4}$$

Where dE/dt is the "pump rate," i.e. net flow of external energy through the boundaries of the open system. Like adding resistances in a parallel circuit with Kirchoff's laws

$$\frac{1}{T_{eff}} = \frac{1}{T_{closed}} + \frac{1}{T_{open}} = \frac{1}{T_{closed}} + \frac{1}{\Xi}\frac{dE}{dt} \tag{2.5}$$

The limit of a closed system is $dE/dt \to 0$, hence $T_{eff} \to T_{closed}$. In contrast, as the pump rate $dE/dt \to \infty$, $T_{eff} \to T_{open} \to 0$ for T_{closed} held fixed as the pumped system is also in

thermal contact with a random heat reservoir. Therefore, we can imagine room temperature externally pumped atomic gas Bose-Einstein condensates, pumped open high temperature superconductors. Indeed, all living matter[6] may consist of suitable biological Bose-Einstein condensates at room temperature. The pumping shields the Bose-Einstein condensate in the open system from thermal disruption. In particular, Max Tegmark's "hot brain" refutation that quantum mind could not be a Bose-Einstein condensate because of thermal decoherence does not apply to this class of pumped open systems. Indeed, a non-equilibrium Bose-Einstein condensate consists of a macroscopic occupation of a single low dimensional quantum state in a small subspace of configuration space by a huge number of identical qubits that are not at all entangled with each other. That is, the N qubit quantum density matrix $\rho_N\left(x_1, x_2, ... x_N \mid x_1', x_2', ... x_N'\right)$ over the large configuration space factorizes, i.e. disentangles into the long range quantum phase coherent local Bose-Einstein condensate

$$\rho_N\left(x_1', x_2', ... x_N' \mid x_1, x_2, ... x_N\right) \rightarrow \rho_1[x', x]^N \tag{2.6}$$

where

$$\rho_1\left(x' \mid x\right) = \Psi_s^*\left(x'\right)\Psi_s\left(x\right) + \rho_n\left(x' \mid x\right) \tag{2.7}$$

with a local internal non-gauge force U(1), but robust, long-range phase coherent order parameter "signal" Ψ_s *derandomizing* the "noise" fluctuations[7] found locally in entangled qubit systems.

The generalized "superfluid density" is

$$\rho_s\left(x\right) = \lim_{x' \to x} \Psi_s^*\left(x'\right)\Psi_s\left(x\right) \tag{2.8}$$

The "normal fluid" density of this "two-fluid" open pumped high-temperature non-equilibrium system that mimics a closed system at near absolute zero is

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[6] Indeed, all living matter must be sub-quantum nonequilibrium, i.e. "post-quantum" with "signal nonlocality" violating "passion at a distance" in the sense of the quote from Antony Valentini in Footnote 1 above. We do not need to look for "relic particles from the early universe", though I have no objection to doing so. Like Narcissus, we need only gaze in wonder at our own reflection in the bathroom mirror.

[7] They can be zero point quantum vacuum fluctuations for a virtual off-mass shell Bose-Einstein condensate, or, they can be classical noise sources for a real on mass shell Bose-Einstein condensate. "On mass shell" is the pole of the relevant Feynman propagator in the complex energy plane in flat spacetime with the full unbroken Poincare group symmetry of the completely locally random zero point fluctuating false vacuum with cutoff ~ 10-33 cm that would antigravitate if it could, but it can't in the sense of counterfactual definiteness. There is no gravity as we observe it in this primordial false vacuum. Direct quantization of general relativity is a wrong idea. That is what the brute force unrenormalizability of quantum gravity is telling us. Classical curved spacetime emerges from a spontaneous broken internal U(1) symmetry as a noise-quieted collective coherent mode out of the zero point gauge force and source "quantum foam".

$$\rho_n(x) = \lim_{x' \to x} \rho_n(x'|x) \qquad\qquad (2.9)$$