Available online at www.worldscientificnews.com

World Scientific News

WSN 49(2) (2016) 346-380 EISSN 2392-2192

Theoretical Investigations into the Fundamental Understanding of the Nature of Time, Gravity and Dynamics

Koustubh Kabe

Department of Mathematics, Gogte Institute of Technology, Udyambag, Belgaum (Belgavi) – 590 008, Karnataka, India

and

Department of Physics, Lokmanya Tilak Bhavan, University of Mumbai, Vidyanagari, Kalina Campus, Santacruz (East), Mumbai – 400 098, India

E-mail address: kkabe8@gmail.com

The rarest and most valuable of all intellectual traits is the capacity to doubt the obvious.
− Albert Einstein

Dynamics doesn't begin with the universe, with the dynamics begins the universe
− Koustubh Kabe

ABSTRACT

The origins of dynamics, the physical basis of time asymmetry and the nature of gravity are all considered in the model discussed in this paper. The theory takes entropy as not a sheer thermodynamic property but rather considers it as a Quantum Field Theoretic property that emanates from a fundamental field. Also it is quantized, the most fundamental unit being the value of the Boltzmann constant. Ab initio the reason for entropy being a quantum field property is systematically argued. We explicitly show how the fields gain the property of entropy. First and foremost, we get rid of the Penrose-Hawking Big Bang singularity involving all spacetime, by proposing the existence of closed timelike geodesics below the Planck scale since that's where GR ceases to function. We argue that this corresponds to a breaking of Lorentz covariance symmetry below the Planckian scale. We then explicitly show this symmetry to be broken and then obtain an anomalous current that is non-conserved; we later demonstrate that this is the non-conserved entropy current. This explicitly shows the Planckian nature of the irreversible thermodynamics that yields entropy currents. The static vortex gauge theory that interacts with the entropy endowing $K - field$ actually gives a degree of randomness to the field and endows it with dynamics and gives it the ability to give dynamics to all the other fermionic and bosonic fields including gravity. The acquiring of the property of mass by this field via the Anderson-Higgs mechanism makes the dynamics finite. The positivity of entropy and the mass make the dynamics finite and time asymmetrical. Finally we construct a Hamilton-Volterra system of equations and imposing a special gauge which we call the "Pauli Gauge", and then consider the diffusion of curvature mathematically defining it by the Ricci flow, we deliver the pure gravity Einstein field equations. This paper all in all represents a model that gives a new way to think about the origins of dynamics, asymmetry of time, nature of gravity and the finiteness of dynamics.

Keywords**:** holonomy; entropy; time asymmetry; gravity; Anderson-Higgs mechanism; gauge field; vorticity; dynamics; spontaneous symmetry breaking; Big Bang singularity

1. INTRODUCTION

The theory of gravity is intricately connected to the theory of dynamics, and this, to theory of thermodynamics. Motion for quantum matter, by its very basic essential nature, random and statistical. Hence thermodynamics seems to creep in every time some endeavor is made to quantize gravity. However, it is a must to understand that thermodynamics should be used correctly and interpreted justly and rightly in the regime where the quantum and the gravitation are left to play together to orchestrate the symphony called the beginning of everything. The work of Verlinde [1] suggests the entropic origins of gravity. The methods used in that paper were found unpalpable to the author and therefore culminated into paper amplifying statistical foundations applied along with the holographic principle to gravity [2,3]. Many thermal interpretations have given to gravitating systems and key among them figure the relatively recent works of Padmanabhan [4]. However, a genuine endeavor can be made in the understanding of time, gravity and the foundational nature and characterization of dynamics only when one redoes the thinking part more radically and offers more radical perspectives. The current paper is an attempt to do so. Some of the mathematical methods are borrowed from the subset of the standard model, namely, the Global and the Local Spontaneous Symmetry Breaking and the corresponding Nambu-Goldstone and Anderson-Higgs tricks. For the case of the entropy giving mechanism some manipulations have been made to do away with mass and instead bring in entropy in the Planck scale domain and within. The charge of the standard model is then replaced with the entropy and for reasons of completeness and pedagogy for the novice theoretical physicist and cosmologist, the Nambu-Goldstone and Anderson- Higgs mechanisms have been repeated, with the endowed entropy instead of the electric charge of the standard model, to account for the mass acquisition so vitally required in order to deliver limited dynamics. The earlier non-conserved anomalous currents obtained in the explicit spontaneous breaking of the Lorentz symmetry earlier are therein accounted for by the non-conserved entropy currents. Thus, the Planck scale fundamental nature of the entropy and the ensuing irreversible thermodynamics is established.

2. FULL TEXT: ENTROPY, DYNAMICS, TIME ASYMMETRY AND GRAVITY

Dynamics is the gravitational property of any system. The dynamics of any physical system seems to be connected intricately with the property of mass and the initial conditions thus connecting it to quantum gravity and thermodynamics. Why we take up the connection with thermodynamics as a primary concern is because of the connection of geometry and information [2,3]. In other words, entropy, is a key physical property, here; and it seems to be intimately connected with dynamics and just as well with mass.

If the process of giving a velocity v to a system can be regarded as an adiabatic process, then the entropy remains unchanghed and has the same value as for a stationary system, or that it is Lorentz invariant,

$$S' = S. \tag{2.1}$$

This is in accordance with the statistical mechanical interpretation of entropy in terms of probability, since the probability of finding a system in a given state is independent of the velocity of the observer. As it turns out, entropy for gravity and spin systems is non-concave. Let's look at entropy and examine the third law of thermodynamics, proposed by Nernst in the famous Nernst theorem: *the entropy of a perfect crystal tends to zero as its absolute temperature T tends to zero and this entropy becomes zero at the absolute zero of temperature wherein all atomic and all other possible motion ceases in the matter*. It is reasoned out on thermodynamic basis that because all motion ceases hence entropy becomes zero. Actually, the current status of work on gravity [1] suggests that gravity is not a primary force after all. So, the force of gravity comes into existence somewhere along the way when the Higgs interaction occurs and mass is endowed upon the constituents of the universe. The property of dynamics just like mass is also an endowed property. As stated above, if taken in reverse, i.e., in the order of the beginning of the universe, as we know it, or from the scales of the quantum gravity domain way upwards, it is because the entropy vanishes, that all motion ceases. This is because the universe is not made up of objects but of physical processes. Entropy by that same token, is a measure of a process – loss of information. It is more than that – it is the degree of randomness.

Actually, it should be clear to any genuinely thinking physicist that the laws of thermodynamics, the second and third law, and the statistical foundations of these laws stem from the common probabilistic experiences of every physical event or an ensemble of a set of physically related events. It is due to the incapability to predetermine the occurrence of any event – that probability theory arises and through it nucleates thermodynamics including the empirical foundations of thermodynamics. The true nature of thermodynamics should not be assessed by means of the analogies with strong gravitational processes, gravitationally strongly correlated systems and the quantities derived therein, but rather considered carefully from a critical perspective by making it a field theoretic object. Entropy described above suits this purpose and a lot can be explained, just by considering the Shannon entropy, S, related to the information, I, as

$$\Delta S = -\Delta I. \tag{2.2}$$

Gravity, at its very base should not include thermodynamics but should arise as a feature of dynamics only after the correct symmetry is spontaneously broken and the Lorentz "symmetry" and the characteristic causality is delivered as a broken symmetry. Quantum gravity, should therefore not be the real concern of any physicist. It is highly probable that certain thermodynamic quantities are at the base of field theory in that they are in fact actual field theory variables or conserved charges: e.g. entropy as some kind of Nöther charge has been shown by Wald [8], and these deliver "dynamics". The most noteworthy feature strongly supporting these seemingly unconventional and ad hoc arguments is the entry of the Boltzmann constant k_B in the Hawking-Unruh analysis of quantum blackholes and thermogravity [6,7]. As the blackhole entropy is some sort of conserved Nöther charge [8], we take a direct leap to generalize as follows.

Entropy S is quantized, and the smallest unit of entropy is $s = k_B = 1.38 \times 10^{-23} JK^{-1}$. Now, it was Clausius who introduced the notion of entropy. But, Boltzmann gave it a clearer meaning. So, we propose the unit Boltzmann abbreviated – Bz – for entropy for our convenience, keeping it now as a fundamental physical quantity and not the $\delta Q / T$ quantity as defined by the second law of thermodynamics (thus, $s = k_B = 1.38 \times 10^{-23} Bz$ – written out as the unit of the degree of randomness). Rather, as stated earlier in the Nernst theorem formulation of the third law, we take the reverse order not only for the laws of thermodynamics but actually for physical processes within the laws themselves. Thus, entropy is actually endowed to the system by a fundamental interaction field just like the Higgs field which gives mass as we very well know. This field gives the physical property of dynamics to the particles within the system and to the system as a whole itself. This field also self-interacts thus making itself dynamical as well. All this will be seen to be theoretically demonstrated in the paper. So, now the entropy of any physical system is a quantity responsible for physical motion. Gravity by its very nature is irreversible and positive entropy change is deeply rooted inherently in irreversible processes. So, gravity and entropy are definitely related. We first consider bits and pieces in here and then finally fit the jigsaw puzzle to get the big picture – the physical asymmetry of time is characteristic of this line of reasoning. It is in this way that thermodynamics and quantum gravity come into a single physical picture simultaneously and not just the case of blackhole horizon area and its related entropy and the forcefully associated different kinds of blackhole evaporation processes. Coming back to the problem of time asymmetry now….. Hawking and Penrose have stated that if certain general conditions are satisfied including the positivity of energymomentum, then a singularity of spacetime is unavoidable. Such a singularity is asserted by Hawking to be present just before the beginning of the universe and involves all spacetime – the universe and its content in a single undefined singular moment wherein nothing exists except something of infinite curvature and infinite density. As we scale backwards in time, we get a zero existence and no physical laws. But what if even one of these general Penrose-Hawking conditions is invalid or violated as one scales backwards in time and length? You see, one of these conditions is the non-existence of closed timelike geodesics. So, the time asymmetry is assumed as a necessary condition here, extrapolated back to the very beginning. This is the reason why no proper cause is found for the beginning (Big Bang) and the existence of the universe. Especially, the problems of inflation or the matter-antimatter asymmetry are noteworthy vexing problems. A clue to the matter-antimatter asymmetry is provided by the Feynman approach to QED. In this approach, an antiparticle moving backward in time is equivalent to a particle moving forward in time. This provides a further advantageous advancement – simply drop the Penrose-Hawking condition of non-existence of closed timelike geodesics but only below a certain length scale and a corresponding time scale – the Planck scale viz., $\lambda_{Pl} = \sqrt{G\hbar/_{c^3}} \approx 10^{-33} cm$. The consequence is the existence of an abelian $U(1)$ holonomy over a field of geodesics for gravity so that any test timelike geodesic x^μ now transits to the form $x^\mu \to e^{-i\theta} x^\mu$ where the geodesic equation $\frac{d^2 x^\mu}{ds^2} + \Gamma^\mu_{\rho\sigma} \frac{dx^\rho}{ds} \frac{dx^\sigma}{ds} = 0$ is no longer invariant under the holonomy transformation of the time-like geodesics. Substituting, the holonomy transformed geodesic curve we get an equation of type:

$$\frac{d^2 x^\mu}{ds^2} + e^{-i\theta} \Gamma^\mu_{\rho\sigma} \frac{dx^\rho}{ds} \frac{dx^\sigma}{ds} + x^\mu \left(\frac{d\theta}{ds}\right)^2 + i\left[x^\mu \frac{d^2\theta}{ds^2} + \left(\frac{d\theta}{ds}\right)\left\{\frac{dx^\rho}{ds} + \frac{dx^\sigma}{ds} + e^{-i\theta}\left(x^\sigma \frac{dx^\rho}{ds} + x^\rho \frac{dx^\sigma}{ds}\right)\right\}\right] = 0 \qquad (2.3)$$

The gauge defined by setting the third term plus the fourth large bracketed term equal to zero does not redeliver the geodesic equation due to the presence of the phase attached to the affine connection. Thus gauge transformations cannot waive away the holonomy of a gauge field with , here $U(1)$ symmetry. On the other hand, setting $\theta = 0$, quickly removes the holonomy phase from the equation and delivers back the original geodesic equation and redefines the original open timelike geodesics. This choice of the phase is holonomy fixing. It has spontaneously broken the gauge field symmetry with $U(1)$ holonomy. The quantum entropy s, is related to a quantum of action. At the Planck scale,

$T_{Pl} = \frac{E_{Pl}}{k_B}$ or $s \propto \sqrt{\hbar}$. In other words, action $\mathcal{A} = const. \times\ S^2$. The entropy plays itself out in the static gauge field picture and gives everything in the universe and the universe the property of dynamics. Gravity then comes into the picture and order this random dynamics.

2. 1. THE ORIGIN OF VORTICITY

Time and Background Independent Vorticity

Theorem: *Let t be the time and Γ be the circulation due to the vorticity associated with the quantum system; then, for the analytical continuity between the wavefunctions, each separately containing the canonical conjugate pairs of energy-time and mass-vorticity, leads to a linear relation between time and the circulation of the precise form given by*

$t = \frac{\Gamma}{c^2}$.

Proof:

Consider the configuration space $\mathcal{C}_{GR}$ of General Relativity whose cotangent bundle is the Hamiltonian phase space of the $SL(2,\mathbb{C})$ Yang-Mills gravity gauge. Here, for every ground state variable $|\psi(0)\rangle = |n, R(0)\rangle$ in the abstract vector space or the Dirac space, we have a wave function in the (Hilbert space) diffeomorphism invariant square integrable cross-sections of the vector bundle associated with the quantum system, here gravity – a system with finite number of degrees of freedom. Now, we have a simple familiar wave function $\psi(x) = \langle X|\psi\rangle = e^{i(pq-Et)}$ for any quantum system embedded in gravity. For our purpose for this quantum system embedded in gravity, postulate the existence of an azimuthal $1-form$ — a bra: $\langle\varphi|$, whose inner product with the corresponding ket, $|\psi\rangle$, yields the corresponding angular wave function or spin function $\psi(\varphi) = \langle\varphi|\psi\rangle = e^{i(J_z\varphi - m\Gamma)}$. Now this form we postulate as the equivalent form for the quantum mechanical wave function. We further postulate that every field phenomenon can be modeled into a spin system (see [5] and references therein) and thereby viewed as a collective phenomenon. This means that gravity also may be viewed as an Ising model of light cones.

Fix now an isomorphism, υ, between the frame relative to which the quantum mechanical matter system is stationary and that of gravity i.e., the frame of the stationary observer in which the quantum system is dynamical. This isomorphism is the relative or Lorentzian velocity of the quantum system relative to the inertial frame of reference of our observer. The isomorphism allows for the velocities of both, the system's frame and the inertial frame, to be converted into each other via Einstein's velocity addition theorem. This provides for a time independent formulation of the Einstein velocity addition theorem. The relativistic nature of the dynamics is therefore conserved in the Poisson algebra of the Lagrange-Hamilton isomorphisms taken above. The constraint functionals generate canonical transformations which result in the rotation of the isomorphism indices. The isomorphisms are time-void generators of dynamics in 3-space. This is how the dynamics can be measured in the temporal gauge. As the quantum system moves with a relative velocity $\mathscr{v}$ and thereby traces a geodesic in the continuum, the generalized velocity of this quantum system traces a trajectory on the constraint surface. Thus the transition of the quantum system from a state $|\psi(0)\rangle = |n, R(0)\rangle$, to another state $|\psi(t)\rangle = |n, R(t)\rangle$, is given by the transition amplitude expressed as the time-void path integral between two points on the constraint surface.

Define a vorticity, W of $\mathscr{v}$, in a time-void $d = 3\,space$ — a fluid of future light cones, as

$$W := \nabla \times \mathscr{v} \tag{2.1.1}$$

where, the differential form convention has been used as in [1]. Now, fix an automorphism, $\mathscr{u}$, of the constraint surface of gravity representing the bulk of the surface states/light cone fluid giving the collective dynamical behavior of the space — its velocity of flow. In other words, fix an isomorphism between two quantum fundamental observers' frames. This velocity also is time-void. For canonical vorticity, W, we have

$$\Gamma := \int_{\mathcal{S}} W \cdot dS = \oint_{\lambda} \mathscr{v} \cdot dl \tag{2.1.2}$$

where, Γ, the circuit integral is the circulation which is also time void.

The analytical continuity of the functions $\psi(x)$ and $\psi(\varphi)$ tells us that pq corresponds to $J_z\varphi$ and similarly Et corresponds to $m\Gamma$ so that we have
by the Einstein theorem of inertia of energy that

$$Et = \frac{E}{c^2}\Gamma \tag{2.1.3}$$

Thus time arises naturally as a kind of vorticity, although gravity doesn't arise until curvature is involved; or

$$t = \frac{\Gamma}{c^2}. \tag{2.1.4}$$

This proves our above theorem. ■

Now, for an inviscid liquid, with canonical time ϑ measuring its motion in the configuration space of general relativity, the vorticity, W, satisfies the equation

$$\frac{\partial W}{\partial \vartheta} = curl\, u \times W. \qquad (2.1.5)$$

Eq (5) tells us that the vortex lines are dragged with the fluid moving a velocity u. Thus, we perceive spacetime rather than space and time. The Landau-Raychaudhuri equation tells us that vorticity causes expansion and shear causes contraction in spacetime.

By the eq (5)we see that time is bound to the light cones, in terms of causality. Now whereas,

$$\Gamma = \oint \boldsymbol{w} \cdot d\boldsymbol{l} = \oint (\nabla \times \boldsymbol{v}) \cdot d\boldsymbol{l} \qquad (2.1.6)$$

to be say, positive, we have $\Gamma = -\oint \boldsymbol{w} \cdot d\boldsymbol{l}$, so that vorticity line integral can change sign over contour direction. Change in the direction of the contour however, that acausality is the inherent direction of time and this cannot be gauged out since it is then no longer an unphysical gauge degree of freedom of gravity. But this we all know; what is new is that we now know is that acausality can merely be gauged out as follows:

$\Gamma = -\oint \boldsymbol{w} \cdot d\boldsymbol{l} \;\; \Longrightarrow t < t_0$ (for some $t_0 > 0$) for $\boldsymbol{w} = -\nabla \times \boldsymbol{v}$. Define then $\boldsymbol{v}' = \boldsymbol{v} + \nabla\Lambda$. In so doing, $\nabla \times \boldsymbol{v}' = \nabla \times \boldsymbol{v}$as $\nabla \times \nabla\Lambda = 0$. This shows that for suitable Λ, $-\nabla \times \boldsymbol{v} = \nabla \times (-\boldsymbol{v})$so that $\nabla \times \boldsymbol{v}' = \nabla \times (-\boldsymbol{v} + \nabla\Lambda) \ni \nabla\Lambda > |-v| \Longrightarrow \boldsymbol{w} > 0 \Longrightarrow \Gamma > 0 \Longrightarrow t > 0 \; \forall \, t > t_0$. We also observe that for different velocities, the vorticity is the same. Thus, the velocity, in the relativistic field theoretic formulation, is a static gauge theory.

2. 2. QUANTUM GRAVITY AS A NON-TENSORIAL PHENOMENON UNDERLYING SPONTANEOUSLY BROKEN LORENTZ SYMMETRY

The theory of quantum gravity in one way is to construct an interaction Hamiltonian – a Weinberg Hamiltonian [9] that can create and destroy gravitons and then one can calculate transition probabilities as a power series in this interaction. The Hamiltonian required is made out of the Weinberg quantum fields:

$$h_{\rho\nu}(x) = \sum_{\mu} \int d^3k \left\{ a(\boldsymbol{k},\mu) e_{\rho\nu}(\boldsymbol{k},\mu) e^{ik_\lambda x^\lambda} + a^\dagger(\boldsymbol{k},\mu) e^\star_{\rho\nu}(\boldsymbol{k},\mu) e^{-ik_\lambda x^\lambda} \right\} \qquad (2.2.1)$$

Here, $e_{\rho\nu}(\boldsymbol{k},\mu)$ is the polarization tensor for a graviton of momentum $\hbar\boldsymbol{k}$ and helicity μ and $a(\boldsymbol{k},\mu)$ and $a^\dagger(\boldsymbol{k},\mu)$ are the annihilation and creation operators characterized by the commutation relations

$$[a(\boldsymbol{k},\mu), a^\dagger(\boldsymbol{k}',\mu')] = \delta^3(k - k')\delta_{\mu\mu'} \qquad (2.2.2)$$

$$[a(\boldsymbol{k},\mu), a(\boldsymbol{k}',\mu')] = [a^\dagger(\boldsymbol{k},\mu), a^\dagger(\boldsymbol{k}',\mu')] = 0 \qquad (2.2.3)$$

Now, the operator $h_{\rho\nu}(x)$ is not a Lorentz tensor as long as the helicity sum is limited to the physical values $\mu = \pm 2$. A true tensor will have helicities $0, \pm 1\ and\ \pm 2$. The the initial absence of these helicities will be supported by the fact that our quantum field interaction Hamiltonian will not be Lorentz covariant; it will begin by breaking the Lorentz invariance. To start with a true tensor and then subject $e_{\mu\nu}$ to a gauge transformation to eliminate the helicities $0\ and\ \pm 1$ also renders $h_{\mu\nu}$ a non-tensorial one. To restate this alternately, say,

$$e_{13} = e_{23} = e_{33} = e_{03} = e_{10} = e_{20} = e_{00} = 0$$

For $\boldsymbol{k}$ in the $3 - direction$ renders Lorentz non-invariance.

The problem is now not so much as to only understand the graviton interaction problem as much as the occurrence of the helicities $0\ and\ \pm 1$. So we adopt the following approach:

Vortex gauge theory is a static gauge theory as seen above. The gauge field V_μ^a is naturally related to spin in our formalism developed below and therefore vorticity and spin are related in what follows. There is a certain reduction ansatz [10] that when fixed for a classical non-abelian gauge theory breaks the Lorentz symmetry of this gauge theory. Such a symmetry breaking is convenient because the result is a quantum mechanical gravity which is not Lorentz invariant. This is not some unwanted accident. The, Einstein GR ceases to function below the Planck scale and we have seen above that the Weinberg tensor loses its tensorial character upon gauge transforming away the spin 0 and 1. We consider the $SU(2)$ gauge field $V_\mu^a(x)\{\mu = 0,1,2,3; a = 1,2,3\}$ (to get back the tensorial character by accounting for the spin 0 and 1 parts in turn by by construing the vortical static gauge theory and relating it to gravity through the former's acquiring the property of dynamics and endowing the same dynamics unto other particles and fields upon interaction; what follows in the paper is an algorithm for this entire picture) and let

$$V_\mu^a = e^{-i\lambda_\mu(x)}\sigma^a \tag{2.2.4}$$

Where $\lambda_\mu(x)$ is the $U(1)$ gauge field and the σ^a s are the Pauli matrices, which satisfy the usual commutation relations:

$$[\sigma^a, \sigma^b] = 2i\varepsilon_{abc}\sigma^c \tag{2.2.5}$$

The choice of ansatz (4) is based on the following grounds: *the infinite spacetime degrees of freedom which are those characterizing a field theory, are eliminated thereby leaving behind only internal degrees of freedom. This is realized by choosing the ansatz (2.2.4) which for the*

$SU(2)$ gauge field, separates the dependence on spacetime coordinates from that on the internal degrees of freedom. In this first step, the Lorentz symmetry is broken and corresponds to the $U(1)$ holonomy of the closed timelike geodesic fields. Here, however, the gauge invariance is preserved. In a second step, we look for a particular limit, of the spacetime dependent part of the ansatz, which leads to a vacuum solution of the field equations.

The choice of the gauge ansatz (2.2.4) thus explicitly breaks Lorentz invariance.

In the second step as planned we take the limit case:

$$\lambda_\mu(x) = 0 \tag{2.2.6}$$

Consider the $SU(2)$ gauge transformations performed on the original static gauge field

$$V_\mu = V_\mu^a \sigma_a / 2 \tag{2.2.7}$$

that is

$$V_\mu \xrightarrow{U} V'_\mu = U V_\mu U^{-1} - \frac{i}{g} U \partial_\mu U^{-1} \tag{2.2.8}$$

where g is the gauge coupling constant, U being given by

$$U = e^{i\rho^a(x)\sigma^a/2} \tag{2.2.9}$$

and $\rho^a(x)$ are three arbitrary real functions.

By the use of (2.2.7) the gauge ansatz (2.2.4) can be rewritten as

$$A_\mu = e^{-i\lambda_\mu(x)} \text{, say} \tag{2.2.10}$$

The ansatz (2.2.10) transforms under (2.2.8) as

$$e^{-i\lambda_\mu} \xrightarrow{U} e^{-i\lambda'_\mu} = e^{-i\lambda_\mu} - \frac{i}{g} U \partial_\mu U^{-1} \tag{2.2.11}$$

In the limiting case or rather gauge fixing (2.2.6), the transformations (2.2.11) become

$$e^{-i\lambda_\mu} \xrightarrow{U} e^{-i\lambda'_\mu} = 1 - \frac{i}{g} U \partial_\mu U^{-1} \tag{2.2.12}$$

Eq (2.2.12) can be transformed into a pure gauge by a suitable choice of the arbitrary functions $\rho^a(x)$. This means that in the limit case the gauge ansatz (2.2.4) describes a vacuum solution. In the original $SU(2)$ theory invariant under Lorentz transformations, the vacuum state is $|0\rangle$, corresponding to $V_\mu = 0$. In the presence of the gauge ansatz (2.2.4) which breaks Lorentz invariance, there is, in the limit case, a new vacuum state $|\vartheta\rangle$, corresponding to $V_\mu = 1$.

Then, the gauge field V_μ has a non-vanishing v.e.v. (vacuum expectation value) in the new vacuum

$$\langle\vartheta|V_\mu|\vartheta\rangle \neq 0. \qquad (2.2.13)$$

Let us take the temporal gauge $V_\mu = 0$. Then eq (2.2.13) becomes

$$\langle\vartheta|V_k|\vartheta\rangle \neq 0 \quad (k = 1,2,3) \qquad (2.2.14)$$

This indicates that there is a spontaneous symmetry breaking of the little group $O(3)$, to which are associated three new Goldstone bosons φ_k, each one corresponding to a particular $O(3)$ generator.

In the case that these bosons were not self-interacting, they would obey the field equations $\Delta\varphi_k = 0$, where Δ is the Laplacian. However, as we will see in the following deduction, this is not the case. In fact, to satisfy the original $SU(2)$ field equations, these bosons must be the source of a current

$$\Delta\varphi_k = j_k \quad (k = 1,2,3) \qquad (2.2.15)$$

So, let us consider our $SU(2)$ gauge field in the notation convention defined in (2.2.7). Under this convention, the gauge field strength or curvature of the gauge field connection V_μ is

$$W_{\mu\nu} = \partial_{[\mu}V_{\nu]} + ig[V_\mu, V_\nu] \qquad (2.2.16)$$

where [ ] imply antisymmetrization in the indices, that is $\partial_{[\mu}V_{\nu]} = \partial_\mu V_\nu - \partial_\nu V_\mu$. The covariant derivative due to the local nature of the gauge symmetry chosen is inevitable and is therefore,

$$D_\mu = \partial_\mu + igV_\mu \qquad (2.2.17)$$

For the Lagrangian density we have

$$\mathcal{L} = -\frac{1}{4}W_{\mu\nu}W^{\mu\nu} \qquad (2.2.18)$$

And finally, we have the vorticity static gauge field equations

$$D_\mu W^{\mu\nu} = 0 \qquad (2.2.19)$$

In terms of the ansatz (2.2.10), equations (2.2.16), (2.2.17) and (2.2.18) respectively, take the form

$$F_{\mu\nu} = i(e^{-i\lambda_\mu}\partial_\nu\lambda_\mu - e^{-i\lambda_\nu}\partial_\mu\lambda_\nu) \qquad (2.2.20)$$

$$D_\mu = \partial_\mu + ige^{-i\lambda_\mu} \qquad (2.2.21)$$

$$\mathcal{L} = \frac{1}{4}\left[e^{-2i\lambda_\mu}\left(\partial_\nu\lambda_\mu\right)^2 + e^{-2i\lambda_\nu}\left(\partial_\mu\lambda_\nu\right)^2 - 2e^{-i(\lambda_\mu+\lambda_\nu)}\partial_\nu\lambda_\mu\partial_\mu\lambda_\nu\right] \qquad (2.2.22)$$

Notice that in (2.2.22) there is a “mass term” $-\frac{1}{2}V_\mu V_\nu \partial_\nu \lambda_\mu \partial_\mu \lambda_\nu$ for the $SU(2)$ vorticity gauge field V_μ in the ansatz (2.2.10). The conserved Nöther current j_ν^Nin terms of the gauge rule becomes

$$j_\nu^N = \frac{\partial \mathcal{L}}{\partial e^{-i\lambda_\nu}} = e^{-i\lambda_\nu}\left[\left(\partial_\mu \lambda_\nu\right)^2 - \partial_\nu \lambda_\mu \partial_\mu \lambda_\nu\right] \quad (2.2.23)$$

Finally, the vortex field equations written in terms of the ansatz become

$$e^{-i\lambda_\mu}\partial_\mu \lambda_\mu \partial_\nu \lambda_\mu - e^{-i\lambda_\nu}\left(\partial_\mu \lambda_\nu\right)^2 + ie^{-i\lambda_\mu}\partial_\nu\left(\partial_\mu \lambda_\mu\right) - ie^{-i\lambda_\nu}\partial_\mu \partial^\mu \lambda_\nu - ge^{-i\lambda_\mu}\left(e^{-i\lambda_\mu}\partial_\nu \lambda_\mu - e^{-i\lambda_\nu}\partial_\mu \lambda_\nu\right) = 0 \quad (2.2.24)$$

In the Lorentz gauge, $\partial_\mu \lambda_\mu = 0$, the first term and the third terms in (2.2.24) vanish, and the field equation can be rewritten as

$$e^{-i\lambda_\nu}\left(\partial_\mu \lambda_\nu\right)^2 - ie^{-i\lambda_\nu}\partial_\mu \partial^\mu \lambda_\nu = j_\nu \quad (2.2.25)$$

where $\partial_\mu \partial^\mu$ is D’Alembertian, and j_ν is the current

$$j_\nu = ge^{-i\lambda_\mu}\left(e^{-i\lambda_\mu}\partial_\nu \lambda_\mu - e^{-i\lambda_\nu}\partial_\mu \lambda_\nu\right) \quad (2.2.26)$$

which is not conserved, since

$$\partial_\nu j_\nu = ge^{-i(\lambda_\mu+\lambda_\nu)}\left[i\left(\partial_\mu \lambda_\nu\right)^2 - \partial_\mu \partial^\mu \lambda_\nu\right] \quad (2.2.27)$$

Notice that the gauge rule (2.2.10) puts in evidence the fact that the anomaly (2.2.26) is due to the self-interaction of the $SU(2)$ vorticity gauge field.

The last term in (2.2.24) describes a self-interaction of the $U(1)$ gauge field λ_μ. In the vacuum,

$$\lambda_\mu = 0, \quad V_\mu = 1 \quad (2.2.28)$$

the self-interaction must therefore be absent, so that the current (2.2.26) vanishes

$$j_\mu = 0 \quad (2.2.29)$$

From (2.2.26) and (2.2.29), it follows that in the vacuum it holds that

$$\partial_\nu \lambda_\mu = \partial_\mu \lambda_\nu = 0 \quad (2.2.30)$$

Under these conditions, also the first and second terms in (2.2.24) vanish. Moreover, we recall that, in the Lorentz gauge, also the third term vanishes.

Then, in order to satisfy the $SU(2)$ gauge field equations, the fourth term must also vanish. Thus, $\lambda_\nu = 0$. The symmetry breaking in $O(3)$ then yields three massive particles. Each, of these particles is responsible for dynamics in each of the three directions. But if any of these three particles has mass different from the other two then dynamics along any any arbitrary one of the three spatial dimensions will be asymmetrically favored. We will see further that only one of these boson survives. There is also only one current that can be anomalous non-conserved – the entropy current. This will be shown below.

2. 3. A FIRST LOOK AT ENTROPIC INTERACTION AND THE GLOBAL U(1) GAUGE SYMMETRY

First, we consider a complex scalar field $\phi(x)$. The Lagrangian density of a complex Klein-Gordon field in the absence of dynamical-vortical coupling is

$$\mathcal{L}_0 = \partial_\mu \phi^* \partial^\mu \phi - m^2 \phi^* \phi \tag{2.3.1}$$

The Euler-Lagrange equation gives

$$(\partial_\mu \partial^\mu + m^2)\phi = 0 \tag{2.3.2}$$

The Lagrangian density (1) is invariant under the transformation

$$\phi(x) \to e^{ig\eta}\phi(x), \quad \phi^*(x) \to e^{-ig\eta}\phi^*(x) \tag{2.3.3}$$

because

$$\partial^\mu \phi(x) \to e^{ig\eta}\partial^\mu \phi(x) \qquad \partial_\mu \phi^*(x) \to e^{-ig\eta}\partial_\mu \phi^*(x) \tag{2.3.4}$$

In (2.3.3) and (2.3.4), if one wants one can take $g = s$, a quantum of entropy and apply this thereafter; η is an arbitrary constant. Since η does not depend upon space-time point, this transformation is a global gauge transformation and the theory is said to be global gauge invariant under the group $U(1)$. Nöther's theorem tells us that there is a conserved current j^μ given by

$$j^\mu = \phi^* \partial^\mu \phi - (\partial^\mu \phi^*)\phi \tag{2.3.5}$$

satisfying

$$\partial_\mu j^\mu = 0 \tag{2.3.6}$$

or

$$\frac{\partial j^0}{\partial t} + \nabla \cdot \boldsymbol{J} = 0$$

and yielding

$$\frac{d}{dt}\int d^3 x j^0 = -\int d^3 x \nabla \cdot \boldsymbol{J} = \int ds\, \boldsymbol{n}.\boldsymbol{J} = 0 \tag{2.3.7}$$

where $\int d^3\, xj^0 = \mathcal{A}$ is called the charge of the velocity field in general – something like an an action – and is the generator of the gauge transformation. Velocity is now a dynamical property – that functions as an operator and the transformation is the gauge transformation in position coordinate space – our real physical space.

Now, let the parameter η depend upon the spacetime coordinates. Thus,

$$\phi(x) \to e^{ig\eta(x)}\phi(x), \qquad \phi^*(x) \to e^{-ig\eta(x)}\phi^*(x) \tag{2.3.8}$$

As is now known very well indeed, the Lagrangian density (2.3.1) is not invariant under this more general transformation because the derivative acts on phase also and so the transformation becomes

$$\partial^\mu\phi(x) \to e^{ig\eta(x)}\partial^\mu\phi(x) + i\big(g\partial^\mu\eta(x)\big)e^{ig\eta(x)}\phi(x) \tag{2.3.9}$$

In other words, the derivative of the field no longer transforms like the field itself and consequently, the Lagrangian (2.3.1) is no longer invariant under (2.3.8) like the field itself

$$D^\mu\phi(x) \to e^{ig\eta(x)}D^\mu\phi(x) \tag{2.3.10}$$

The field $V^\mu(x)$ is our dynamics gauge field and, by definition transforms like

$$V^\mu(x) \to V^\mu(x) - \partial^\mu\lambda(x). \tag{2.3.11}$$

We then define

$$D_\mu = \partial_\mu + igV_\mu \tag{2.3.12}$$

and it is easy to see that $D^\mu\phi(x)$ indeed transforms under (2.3.8) and (2.3.11) as does (2.3.10).

The invariance under the local gauge transformation is then restored by replacing ∂_μ by D^μ in the Lagrangian density $\mathcal{L}_0$; thus

$$\mathcal{L}_0 \to \mathcal{L}_I = D_\mu\phi^* D^\mu\phi - m^2\phi^*\phi = (\partial_\mu - igV_\mu)\phi^*(\partial_\mu + igV_\mu)\phi - m^2\phi^*\phi$$
$$= \partial_\mu\phi^*\partial^\mu\phi - igV_\mu\{\phi^*\partial^\mu\phi - (\partial^\mu\phi^*)\phi\} + g^2V_\mu V^\mu\phi^*\phi - m^2\phi^*\phi \tag{2.3.13}$$

This Lagrangian density is invariant under (2.3.8) and (2.3.11) and it contains the gauge field V_μ. We will have to add to (2.3.13) its kinetic energy, the derivative terms. This term must be gauge invariant also. If we define

$$W^{\mu\nu} = \partial^{[\mu}V^{\nu]} \equiv \partial^\mu V^\nu - \partial^\nu V^\mu \tag{2.3.14}$$

we see that $W^{\mu\nu}$ is invariant under the transformation (2.3.11). We are thus led to the final Lagrangian for dynamics emanating from the endowment of entropy from the K-field in the above mechanism akin to the Higgs mechanism taking $g = s$, as

$$\mathcal{L} = -\frac{1}{4}W_{\mu\nu}W^{\mu\nu} + \mathcal{L}_I = -\frac{1}{4}W_{\mu\nu}W^{\mu\nu} + (\partial_\mu - isV_\mu)\phi^*(\partial_\mu + isV_\mu)\phi - m^2\phi^*\phi \tag{2.3.15}$$

We have achieved the invariance under the local gauge transformation by introducing a vector field V^μ. In this vector field V^μ is the velocity vector potential and $W^{\mu\nu}$ is the vorticity field tensor, the Lagrangian in (2.3.15) then describes a entropy endowed Klein-Gordon field interacting with the $U(1)$ abelian vorticity field. Note that (2.3.15) does not contain a mass term $\frac{1}{2}m^2V_\mu V^\mu$, since such a term would violate the invariance under (2.3.11). In other words, gauge invariance forces the abelian "dynamical" boson to be massless. However, where does the entropy come from? The dynamics seems to occur, from our earlier arguments, when the entropy is endowed to the system. This breaks the symmetry of the gauge field V^μ with $U(1)$ holonomy and liberates the vortices. This takes the system from one disordered state to another. The actual ground state of the systems finds itself to be non-unique. This is due to the non-concave nature of the thermal entropy. As such the entropy induced holonomy breaking of the closed timelike geodesics finds several vacua or holonomy condensates reduced to or rather selected to one. Since spontaneously broken theories are renormalizable, we stick to SSB scheme of the particular Anderson-Higgs mechanism but to endow entropy.

2. 4. LOCAL U(1) GAUGE INVARIANCE AND THE ENTROPIC INTERACTION MECHANISM FOR A STATIC U(1) VELOVITY GAUGE FIELD DELIVERING LIMITLESS DYNAMICS, SCALAR SHOCK WAVES AND VORTICAL VECTOR WAVES

Now, the vacuum or the ground state of the system as we have seen has less symmetry than the Lagrangian density. This is the classic case of spontaneous symmetry breaking (SSB). The vortices liberated due to $U(1)$ symmetry breaking of a gauge field with the U(1) holonomy constitute a system having an infinite number of degrees of freedom. Thus the theory of fundamental elements of dynamics, nucleation of time and gravity and the inherent confinement of everything dynamical to move forward in time must be a spontaneously broken one.

Let us examine the term $m^2 \equiv \mu^2$, at the Planck scale, where the Lorentz symmetry breaks, we make the following manipulative substitution:

$\mu_{Pl} = \frac{E_{Pl}}{c^2} = \frac{k_B T}{c^2} \propto S$ at finite constant temperature. Say with the constant of proportionality σ, the mass term at the Planck scale is the entropy term. Since, we have taken the temperature T appearing here as a constant during this interaction, if the other intensive thermodynamic parameters during this interaction are also constant then we have a first order free energy gap and hence an onset of a first order thermal field theoretic phase transition. Note now that entropy is no longer just a thermodynamic quantity that measures loss of information but rather, it is now a fundamental quantum field theoretical property that endows the property of dynamics upon the system and its constituents by giving them a degree of randomness.

Now, consider a complex scalar field Lagrangian describing its dynamics:

$$\mathcal{L} = \partial_\mu \phi^* \partial^\mu \phi - \sigma S^2 \phi^* \phi - \eta (\phi^* \phi)^2 \quad (2.4.1)$$

$$\mathcal{V} = \sigma S^2 \phi^* \phi + \eta (\phi^* \phi)^2$$

So the energy density $\mathcal{H}$ is

$$\mathcal{H} = \partial_\mu \phi^* \partial^\mu \phi + \sigma S^2 \phi^* \phi + \eta (\phi^* \phi)^2 \quad (2.4.2)$$

which is a sum of kinetic and potential energies of $\phi(x)$ and $\phi^*(x)$ fields. The complex field is obtained as

$$\phi = \frac{1}{\sqrt{2}}(\phi_1 + i\phi_2)$$

where ϕ_1, ϕ_2 are real fields. $\eta > 0$ as $\mathcal{V}$ has a minimum only if $\eta > 0$, else $\mathcal{V}(|\phi|) \to -\infty$ as $|\phi| \to \infty$, i.e., the Hamiltonian has no minimum and hence no vacuum. This corresponds to non-concave nature of entropy (read the first paper in ref [5]) - i.e., several maxima and hence several end states in the reverse order, in other words corresponding to multiple vacua, here. In this case, given the constant $\sigma > 0$, the position of the minimum depends on the sign of S^2. Suppose that $S^2 \neq 0$. Then there are two possibilities

(1) $S^2 > 0$ when we have a self-interacting scalar field carrying in our case an entropy "charge" – actually just a unit of entropy.

(2) $S^2 < 0$ where we have an example of spontaneously broken theory. Note that the kinetic energy $\partial_\mu \phi^* \partial^\mu \phi$ is non-negative and so is zero only if ϕ is a constant.

For possibility (1), $\mathcal{H} = 0$, if $\phi = 0$, giving $\phi_1 = \phi_2 = 0$ for the vacuum. Thus, there is a unique vacuum at the origin in the $\phi_1 - \phi_2$ plane. $\mathcal{L}$ is invariant under the $U(1)$ group of phase transformations (2.3.3). The unique vacuum is also invariant under (2.3.3). However, if

$S^2 < 0$, as in case (2), then there are nonzero values of $\phi(x)$ for which $\mathcal{H} = 0$. Thus, there is a nonzero field configuration with lowest energy. Now, the end state is singled out so that there unique or concave entropy. The vacuum solution is found by solving the equation

$$\frac{\partial \mathcal{V}}{\partial \phi} = 0 \tag{2.4.3}$$

or

$$\sigma S^2 \phi^* + 2\eta(\phi^* \phi)\phi^* = 0 \tag{2.4.4}$$

So

$$\phi^* \phi = -\frac{\sigma S^2}{2\eta} = \frac{1}{2}(\phi_1^2 + \phi_2^2) \tag{2.4.5}$$

for $\phi \neq 0$. Therefore,

$$\phi_1^2 + \phi_2^2 = -\frac{\sigma S^2}{\eta} = b^2, \text{ say.} \tag{2.4.6}$$

Thus, the system has an infinite number of vacua, which lie on a circle in the $\phi_1 - \phi_2$ plane. Under the action of the transformation (2.3.8), the vacua are transformed into each other. Suppose now we choose one of the vacua, e.g., $\phi_0 \equiv (\phi_1 = b, \phi_2 = 0)$ as the physical vacuum, then the gauge symmetry is spontaneously broken because the state ϕ_0 is not invariant under the transformations. The Lagrangian density is still invariant. To see the structure of the theory, put

$$\phi = \frac{1}{\sqrt{2}}[b + \phi_1'(x) + i\phi_2'(x)] \tag{2.4.7}$$

Then

$$\phi^* \phi = \frac{1}{2}[(b + \phi_1')^2 + \phi_2'^2] = \frac{1}{2}[b^2 + 2b\phi_1' + \phi_1'^2 + \phi_2'^2] \tag{2.4.8}$$

Substituting (2.4.8) in (2.4.1), we get

$$\mathcal{L} = \frac{1}{2}(\partial_\mu \phi_1')(\partial^\mu \phi_1') + \frac{1}{2}(\partial_\mu \phi_2')(\partial^\mu \phi_2') - \frac{1}{2}\sigma S^2[b^2 + 2b\phi_1' + (\phi_1'^2 + \phi_2'^2)]$$
$$-\frac{1}{4}\eta[b^4 + 4b^2\phi_1'^2 + (\phi_1'^2 + \phi_2'^2)^2 + 4b^3\phi_1' + 2b^2(\phi_1'^2 + \phi_2'^2) + 4b\phi_1'(\phi_1'^2 + \phi_2'^2)] \tag{2.4.9}$$

With the help of $\eta b^2 = -\sigma S^2$, (9) becomes

$$\mathcal{L} = \frac{1}{2}(\partial_\mu \phi_1')(\partial^\mu \phi_1') + \frac{1}{2}(\partial_\mu \phi_2')(\partial^\mu \phi_2') + \frac{1}{4}\frac{\sigma^2 S^4}{\eta} + \sigma S^2 \phi_1'^2 - \eta b \phi_1'(\phi_1'^2 + \phi_2'^2) - \frac{1}{4}\eta(\phi_1'^2 + \phi_2'^2)^2 \tag{2.4.10}$$

The Lagrangian density has the following features:

1. The fields ϕ_1' and ϕ_2' have standard kinetic energy terms.
2. The term $\sigma S^2 \phi_1'^2$ can be interpreted as the mass term for the field ϕ_1'. The field $\phi_1'(x)$ thus a particle with entropy S.
3. The field $\phi_2'(x)$ has no entropy term and so describes a highly "trajectorized" particle with no randomness associated with it (this will be the particle following a closed time-like geodesic); also thermodynamically the process is a reversible one for this particle.
4. The gauge symmetry is hidden in the Lagrangian density. Nevertheless, it has the gauge symmetry as can be seen by working backward.

This brings us to a new result: when a topological phase transition occurs due to a symmetry breaking, with a particular holonomy group, liberating vortices, then for each such holonomy symmetry breaking, with the holonomy, and it's corresponding topological phase transition, there exists a entropy free scalar mode or a scalar entropy gap which yields itself as an entropy condition and producing shock waves. These shock waves can be scalar perturbations leading to density fluctuations or vector perturbations giving vorticity or "vector" waves. A third kind, the tensor perturbations describing gravitational waves is also possible. It is however, in general, an actional shock.

Now let us break the local gauge symmetry by starting with the same Lagrangian density as in (2.4.1) and demanding invariance under local phase transformation. From our above consideration we know that we must introduce a entropy free vector field and replace the derivative ∂_μ by the covariant derivative D_μ. A fully phase invariant generalization of (2.3.15) is

$$\mathcal{L} = -\frac{1}{4} W_{\mu\nu} W^{\mu\nu} + D_\mu \phi^* D^\mu \phi - \sigma S^2 \phi^* \phi - \eta (\phi^* \phi)^2 \qquad (2.4.11)$$

Now, the dynamical connection V_μ becomes massive through spontaneous symmetry breaking (SSB) now, we choose for the ground state ϕ_0 with $\phi_1 = b$ and $\phi_2 = 0$ and using for ϕ the expression given in (2.4.7), we have

$$\mathcal{L} = \frac{1}{2}(\partial_\mu \phi_1')(\partial^\mu \phi_1') + \frac{1}{2}(\partial_\mu \phi_2')(\partial^\mu \phi_2') - \frac{1}{4} W_{\mu\nu} W^{\mu\nu} - \frac{1}{2}\sigma S^2 [b^2 + 2b\phi_1' + (\phi_1'^2 + \phi_2'^2)]$$

$$-\frac{1}{4}\eta[b^4 + 4b^2\phi_1'^2 + (\phi_1'^2 + \phi_2'^2)^2 + 4b^3\phi_1' + 2b^2(\phi_1'^2 + \phi_2'^2) + 4b\phi_1'(\phi_1'^2 + \phi_2'^2)] + \frac{g^2b^2}{2}V_\mu V^\mu - gbV^\mu(\partial_\mu\phi_2') + gV^\mu(\partial_\mu\phi_1')\phi_2' + gV^\mu(\partial_\mu\phi_2')\phi_1' + g^2V^\mu V_\mu\phi_1' + \frac{g^2}{2}V^\mu V_\mu \tag{2.4.12}$$

$$\mathcal{L} = \frac{1}{2}(\partial_\mu\phi_1')(\partial^\mu\phi_1') + \frac{1}{2}(\partial_\mu\phi_2')(\partial^\mu\phi_2') - \frac{1}{4}W_{\mu\nu}W^{\mu\nu} + \frac{1}{4}\frac{\sigma^2S^4}{\eta} + \sigma S^2\phi_1'^2 - \eta b\phi_1'(\phi_1'^2 + \phi_2'^2) - \frac{1}{4}\eta(\phi_1'^2 + \phi_2'^2)^2 + \frac{g^2b^2}{2}V_\mu V^\mu - gbV^\mu(\partial_\mu\phi_2') + gV^\mu(\partial_\mu\phi_1')\phi_2' + gV^\mu(\partial_\mu\phi_2')\phi_1' + g^2V^\mu V_\mu\phi_1' + \frac{g^2}{2}V^\mu V_\mu \tag{2.4.13}$$

This Lagrangian density apparently describes the interaction of an entropied, i.e., entropy endowed dynamical vector particle V_μ and two scalar, one with entropy (ϕ) and one without entropy (also ϕ but another), upon counting the number of degrees of freedom in the Lagrangian (2.4.9) before and after translation. There is a clear discrepancy since the physical degrees of freedom cannot be created by a simple change of variables so naturally the Lagrangian density contains superfluous fields. We make the following gauge transformation through which the unphysical field disappears. Let

$$\left.\begin{aligned} \phi(x) &= \frac{1}{\sqrt{2}}[b + K(x)]e^{i\xi(x)} \\ V_\mu(x) &= U_\mu + \frac{1}{gb}\partial_\mu\xi \end{aligned}\right\} \tag{2.4.14}$$

This gauge transformation translates the Lagrangian density (2.4.13) to

$$\mathcal{L} = -\frac{1}{4}U_{\mu\nu}U^{\mu\nu}\frac{g^2b^2}{2}U_\mu^2 + \frac{1}{2}(\partial_\mu K)^2 - \frac{1}{2}(2\eta b^2)K^2 - \frac{\eta}{4}K^4 + \frac{1}{2}g^2U_\mu^2(2bK + K^2) \tag{2.4.15}$$

where $U_{\mu\nu} = \partial_\mu U_\nu - \partial_\nu U_\mu$. The vortex gauge theory on its own is a static gauge theory. Endowing it with entropy by the above $K - field$ mechanism gives the gauge field U_μ a degree of randomness. So, the U_μ gauge field now delivers the property of dynamics to all fields that it interacts with and it interacts with all the known forces since these are dynamical. However, there is one more property that has not come to one's notice viz., the finiteness of time and dynamics. This is possible only if the local gauge symmetry of the U_μ gauge field is broken via the Higgs mechanism. We take up this issue in the following section. This question should also answer the inherent physical asymmetry of time.

2. 5. THE ANDERSON-HIGGS INTERACTION OF THE ENTROPIED DYNAMICAL VELOCITY/VORTICITY GAUGE FIELDS YIELDING LIMIT ON DYNAMICS AND THE TEMPORAL ASYMMETRY

To show explicitly that the dynamics is finite by the Anderson-Higgs mechanism, we show explicitly the interaction of the fields that have acquired entropy by the above mechanism and now proceed to the Higgs interaction. We do this for the case of entropy possessing particle fields. The procedure is the standard one given by Higgs and is found in all texts and monographs on particle physics and the standard model. However, we do this explicit derivation to make the model in the paper complete and the paper itself, self-contained. Also, for pedagogical reasons, non-specialists of particle physics doing cosmology and condensed matter physics will find this self-contained nature of the paper, helpful.

Consider our system to be invariant under a continuous group G of transformations. We examine the ground state of the system. If the system possesses a unique vacuum, invariant under G, we have a situation where the symmetry properties of $\mathcal{L}$ and the vacuum are the same. Under such circumstances, our theory would be a normal one. On the other hand, if our system has several vacua which transform into each other under the transformations in G. then, if for some reason, one of the vacua is singled out as the physical vacuum of the system, the others being declared unphysical, the symmetry is lost and the theory is spontaneously broken. For our simplest example, we consider once again a complex scalar field theory with $\mu^2 < 0$. Let $\phi(x)$ be a complex scalar field whose dynamics is described by the Lagrangian density $\mathcal{L}$ given by

$$\mathcal{L} = \partial_\mu \phi^* \partial^\mu \phi - \mu^2 \phi^* \phi - \eta (\phi^* \phi)^2 \qquad (2.5.1)$$

$\mathcal{L}$ is invariant under the group $U(1)$ of global transformations (2.3.3). The first term is the kinetic energy and the potential energy is given by

$$\mathcal{V} = \mu^2 \phi^* \phi + \eta (\phi^* \phi)^2$$

So the energy density $\mathcal{H}$ is

$$\mathcal{H} = \partial_\mu \phi^* \partial^\mu \phi + \mu^2 \phi^* \phi + \eta (\phi^* \phi)^2 \qquad (2.5.2)$$

which is a sum of kinetic and potential energies of $\phi(x)$ and $\phi^*(x)$ fields. The complex field is obtained as

$$\phi = \frac{1}{\sqrt{2}}(\phi_1 + i\phi_2)$$

where ϕ_1, ϕ_2 are real fields. $\eta > 0$ as $\mathcal{V}$ has a minimum only if $\eta > 0$, else $\mathcal{V}(|\phi|) \to -\infty$ as $|\phi| \to \infty$, i.e., the Hamiltonian has no minimum and hence no vacuum. In this case the position of the minimum depends on the sign of μ^2. Suppose that $\mu^2 \neq 0$. Then there are two possibilities

(1) ($\mu^2 > 0$ when we have a self-interacting scalar field carrying in our case an entropy "charge" – actually just a unit of entropy.

(2) $\mu^2 < 0$ where we have an example of spontaneously broken theory. Note that the kinetic energy $\partial_\mu \phi^* \partial^\mu \phi$ is non-negative and so is zero only if ϕ is a constant.

For possibility (1), $\mathcal{H} = 0$, if $\phi = 0$, giving $\phi_1 = \phi_2 = 0$ for the vacuum. Thus, there is a unique vacuum at the origin in the $\phi_1 - \phi_2$ plane. $\mathcal{L}$ is invariant under the $U(1)$ group of phase transformations (2.3.3). The unique vacuum is also invariant under (2.3.3). However, if $\mu^2 < 0$, as in case (2), then there are nonzero values of $\phi(x)$ for which $\mathcal{H} = 0$. Thus, there is a nonzero field configuration with lowest energy. The vacuum solution is found by solving the equation

$$\frac{\partial \mathcal{V}}{\partial \phi} = 0 \quad (2.5.3)$$

or

$$\mu^2 \phi^* + 2\eta(\phi^* \phi)\phi^* = 0 \quad (2.5.4)$$

So

$$\phi^* \phi = -\frac{\mu^2}{2\eta} = \frac{1}{2}(\phi_1^2 + \phi_2^2) \quad (2.5.5)$$

for $\phi \neq 0$. Therefore,

$$\phi_1^2 + \phi_2^2 = -\frac{\mu^2}{\eta} = b^2, \text{ say.} \quad (2.5.6)$$

This constant 'b' is different from the one used in the above earlier sections for the entropy mechanism; however other letters are taken for various other physical quantities including some for universal constants. Thus, the system has an infinite number of vacua, which lie on a circle in the $\phi_1 - \phi_2$ plane. Under the action of the transformation (2.3.8), the vacua are transformed into each other. Suppose now we choose one of the vacua, e.g., $\phi_0 \equiv (\phi_1 = b, \phi_2 = 0)$ as the physical vacuum, then the gauge symmetry is spontaneously broken because the state ϕ_0 is not invariant under the transformations. The Lagrangian density is still invariant. To see the structure of the theory, put

$$\phi = \frac{1}{\sqrt{2}}[b + \phi_1'(x) + i\phi_2'(x)] \tag{2.5.7}$$

Then

$$\phi^*\phi = \frac{1}{2}[(b + \phi_1')^2 + \phi_2'^2] = \frac{1}{2}[b^2 + 2b\phi_1' + \phi_1'^2 + \phi_2'^2] \tag{2.5.8}$$

Substituting (2.3.8) in (2.5.1), we get

$$\mathcal{L} = \frac{1}{2}(\partial_\mu\phi_1')(\partial^\mu\phi_1') + \frac{1}{2}(\partial_\mu\phi_2')(\partial^\mu\phi_2') - \frac{1}{2}\mu^2[b^2 + 2b\phi_1' + (\phi_1'^2 + \phi_2'^2)]$$
$$-\frac{1}{4}\eta[b^4 + 4b^2\phi_1'^2 + (\phi_1'^2 + \phi_2'^2)^2 + 4b^3\phi_1' + 2b^2(\phi_1'^2 + \phi_2'^2) + 4b\phi_1'(\phi_1'^2 + \phi_2'^2)] \tag{2.5.9}$$

With the help of $\eta b^2 = -\mu^2$, (2.5.9) becomes

$$\mathcal{L} = \frac{1}{2}(\partial_\mu\phi_1')(\partial^\mu\phi_1') + \frac{1}{2}(\partial_\mu\phi_2')(\partial^\mu\phi_2') + \frac{1}{4}\frac{\mu^4}{\eta} + \mu^2\phi_1'^2 - \eta b\phi_1'(\phi_1'^2 + \phi_2'^2) - \frac{1}{4}\eta(\phi_1'^2 + \phi_2'^2)^2. \tag{2.5.10}$$

The Lagrangian density has the following features:

1. The fields ϕ_1' and ϕ_2' have standard kinetic energy terms.
2. The term $\mu^2\phi_1'^2$ can be interpreted as the mass term for the field ϕ_1'. The field $\phi_1'(x)$ thus a particle with mass μ.
3. The field $\phi_2'(x)$ has no mass term and so describes a massless particle.
4. The gauge symmetry is hidden in the Lagrangian density. Nevertheless, it has the gauge symmetry as can be seen by working backward.

This scalar field example is one of the Nambu-Goldstone theorems. Accordingly, we have a massless spinless mode for each independent global continuous symmetry of the Lagrangian which is spontaneously broken. The mode is the Nambu-Goldstone mode.

Now let us break the local gauge symmetry by starting with the same Lagrangian density as in (2.4.1) and demanding invariance under local phase transformation. From our above consideration we know that we must introduce a massless vector field and replace the derivative ∂_μ by the covariant derivative D_μ. A fully phase invariant generalization of (2.4.15) is

$$\mathcal{L} = -\frac{1}{4}W_{\mu\nu}W^{\mu\nu} + D_\mu\phi^* D^\mu\phi - \mu^2\phi^*\phi - \eta(\phi^*\phi)^2 \qquad (2.5.11)$$

Now, the dynamics connection V_μ becomes massive through spontaneous symmetry breaking (SSB) now, we choose for the ground state ϕ_0 with $\phi_1 = b$ and $\phi_2 = 0$ and using for ϕ the expression given in (2.5.7), we have

$$\mathcal{L} = \frac{1}{2}(\partial_\mu\phi_1')(\partial^\mu\phi_1') + \frac{1}{2}(\partial_\mu\phi_2')(\partial^\mu\phi_2') - \frac{1}{4}W_{\mu\nu}W^{\mu\nu} - \frac{1}{2}\mu^2[b^2 + 2b\phi_1' + (\phi_1'^2 + \phi_2'^2)]$$
$$-\frac{1}{4}\eta[b^4 + 4b^2\phi_1'^2 + (\phi_1'^2 + \phi_2'^2)^2 + 4b^3\phi_1' + 2b^2(\phi_1'^2 + \phi_2'^2) + 4b\phi_1'(\phi_1'^2 + \phi_2'^2)] +$$
$$\frac{s^2b^2}{2}V_\mu V^\mu - sbV^\mu(\partial_\mu\phi_2') + sV^\mu(\partial_\mu\phi_1')\phi_2' + sV^\mu(\partial_\mu\phi_2')\phi_1' + s^2V^\mu V_\mu\phi_1' + \frac{s^2}{2}V^\mu V_\mu$$
(2.5.12)

$$\mathcal{L} = \frac{1}{2}(\partial_\mu\phi_1')(\partial^\mu\phi_1') + \frac{1}{2}(\partial_\mu\phi_2')(\partial^\mu\phi_2') - \frac{1}{4}W_{\mu\nu}W^{\mu\nu} + \frac{1}{4}\frac{\mu^4}{\eta} + \mu^2\phi_1'^2 - \eta b\phi_1'(\phi_1'^2 + \phi_2'^2) -$$
$$\frac{1}{4}\eta(\phi_1'^2 + \phi_2'^2)^2 + \frac{s^2b^2}{2}V_\mu V^\mu - sbV^\mu(\partial_\mu\phi_2') + sV^\mu(\partial_\mu\phi_1')\phi_2' + sV^\mu(\partial_\mu\phi_2')\phi_1' +$$
$$s^2V^\mu V_\mu\phi_1' + \frac{s^2}{2}V^\mu V_\mu$$
(2.5.13)

Here, s is the entropy and represents the entropy of the particle corresponding to the field ϕ. This Lagrangian density apparently describes the interaction of a massive dynamics' vector particle V_μ and two scalar, one massive (ϕ) and one massless (also ϕ but another), upon counting the number of degrees of freedom in the Lagrangian (2.5.9) before and after translation. There is a clear discrepancy since the physical degrees of freedom cannot be created by a simple change of variables so naturally the Lagrangian density contains superfluous fields. We make the following gauge transformation through which the unphysical field disappears. Let

$$\left.\begin{aligned} \phi(x) &= \frac{1}{\sqrt{2}}[b + h(x)]e^{i\xi(x)} \\ V_\mu(x) &= U_\mu + \frac{1}{sb}\partial_\mu\xi \end{aligned}\right\} \qquad (2.5.14)$$

This gauge transformation translates the Lagrangian density (2.5.13) to

$$\mathcal{L} = -\frac{1}{4}U_{\mu\nu}U^{\mu\nu}\frac{s^2b^2}{2}U_\mu^2 + \frac{1}{2}\left(\partial_\mu h\right)^2 - \frac{1}{2}(2\eta b^2)h^2 - \frac{\eta}{4}h^4 + \frac{1}{2}s^2U_\mu^2(2bh + h^2) \quad (2.5.15)$$

where $U_{\mu\nu} = \partial_\mu U_\nu - \partial_\nu U_\mu$.

The field ξ has been gauged away. The Lagrangian density (2.5.15) describes, on quantization, two massive particles, a vector – U_μ and a scalar – h which is our Higgs field. The breaking of the $U(1)$ holonomy liberates vortices and in the process there is a production of "vector" waves. The breaking of Lorentz symmetry in this era or regime gives anomalous currents which are non-conservative. These are the entropy currents given by (2.2.26). Also, the vector dynamic meson U_μ has "eaten" the Goldstone boson via the Higgs mechanism and become heavy. The mass of the U_μ meson for elementary entropy $s = k_B = 1.38 \times 10^{-23} boltzmanns$ is $\frac{k_B T_{Pl}}{c^2} = \frac{E_{Pl}}{c^2} = m_{Pl} \approx 10^{-6} g$. This meson is thus difficult to detect at ordinary energy scales and even at scales as huge as the Grand Unification (GUT) scales because of the high magnitude nature of this mass. For the $SU(2)$ gauge symmetry, and a corresponding holonomy, there will three such generators. However, in the nucleation of gravity post the dynamics mediated by the U_μ gauge meson, two of the generators are rendered void by the existence of General Relativistic Gravity. The fact that the Einstein Field Equations are embody the GRT necessitates the cancellation of the other two vector mesons. Otherwise any difference in the masses of the three bosons would favor the dynamics of any test particle along one of the three arbitrary spatial dimensions. That's why there is only one boson and in the cradle of GR gravity, and it causes the dynamics in the spacetime and of the spacetime. However, it is entropy that causes dynamics through the dynamic mesons so we concentrate on the entropy field. To honor Clausius, let's propose to call it a Clausius field. The quantization of the Clausius or K-field Lagrangian yields a Clausion – a quantum of the entropy or K-field. Now, back to the physics – the entropy field has a self-interaction characteristic and hence is non-linear and is itself dynamical. Next, there is a non-conservative force field associated with the entropy as a source. The field is non-conservative because entropy current is non-conservative. Decay is a natural consequence of the Clausius K – field. Thus, whenever there is any decay, Clausions should be present there and there is definitely a K-field interaction involved. This type of decay occurs with the passage of time. It is also highly possible that the radioactive decay is also due to a two-step interaction process associated with the interaction first involving a K-field and then an intermediate vector boson interaction delivering the radioactive decay. The chronomagnetization is thus, merely a broken symmetry. The field for the enrropy source is $C_\mu = \partial_\mu K$ implying a field $C_{\mu\nu}$. We model this field as a gauge field that also interacts with the Higgs field and becomes heavy. Due to the non-conservative nature of the entropy current, for the C-field $C_{\mu\nu}$ the corresponding energy-momentum tensor takes the form:

$$T^{\mu\nu}_{(C)} = -k_0 (C^\mu C^\nu - \frac{1}{2} g^{\mu\nu} C^\lambda C_\lambda). \quad (2.5.16)$$

For $k_0 > 0,$ we have $T^{00}_{(C)} < 0.$ The C-field thus, has a negative energy density that produces a repulsive gravitational effect making the spacetime under question to expand.

Now, we have understood the appearance of the helicities $0\ and\ \pm 1$. The spin 0 for the $\mu = 0$ case is the entropy gap leading to its interpretation as the entropy condition which produces (scalar) shock waves (in ϕ). This can lead to primordial density perturbations. The spin 1 for the $\mu = \pm 1$ case is the "vector wave" leading to vortical motion responsible here, due to the entropy endowing $K - field$, for the dynamics of all in the universe and due to the omnipresence of the $K - field$, dynamics of the regions of the universe where the quantum gravitational interaction is relavant and the Weinberg field $W_{\mu\nu}(x)$ is active by the breaking of the $U(1)$ symmetry. The Weinberg gauge field is given by U_μ given by the second of eq (2.5.14), viz., $V_\mu(x) = U_\mu + \frac{1}{sb}\partial_\mu \xi$. The dynamics is brought about by the entropy $K - field$ interaction. When, by the above gauge transformation, U_μ becomes heavy, the gauge symmetry is broken and the Lorentz covariance is restored. In the process, the constancy of the velocity of light in vacuum is delivered as a limit imposed on the dynamics delivered by the massive U_μ. This will be demonstrated below. The most important is the confinement of everything within the universe and the universe itself to move in one direction in time. The above model is the physical basis of time asymmetry, since

$$\int_{\partial\Sigma} U = \Gamma = t \quad after\ K + Higgs\ interaction \quad (2.5.17)$$

and

$$\int_{\partial\Sigma} V = \Gamma = t \quad before\ Higgs\ interaction. \quad (2.5.18)$$

Thus, the acquiring of mass by U_μ, makes time heavy as well which is the physical reason for time dilation since mass also varies similarly with velocity. So, more clearly, in the face of relativistic explorations, time and mass should vary relativistically in the same way. Thus, in the Galilean frame S' relative to the frame S, $t = \gamma t_0$ just as $m = \gamma m_0$. In the gap between the $K - field$ and the Higgs interaction, time is isotropic and is not heavy so that there is no limit on the velocity of light, although the concept for the techniques amenable to the perfectly manageable quantum field theory is still valid. The gap as it turns out is just the Planckian gap.

You see, Einstein's law of gravitation clearly states that *every object follows a geodesic in the four dimensional spacetime continuum unless it undergoes collisions or unless it is acted upon by electromagnetic forces.* So, a quantum theory of gravity is not just a theory of gravitons and their interaction with matter quanta; it also a theory of the generation of dynamics – of action – of the beginning of the universe and of the diffusion of the gravitons in the Hamilton-Volterra $SU(2)$ gauge fixed mode to yield the vacuum Einstein field equations.

The Higgs interaction gives a positive mass to U_μ. So, the dynamics is confined in time and the entropy keeps on increasing so the dynamics in its very nature is a temporally asymmetrically occurring one.

In scaling from the Planck domain upwards, in the center of mass frame S', the momentum appears for the U_μ as

$$k'^2 = \frac{\hbar^2 k^2}{1 - m_{Pl}^2 v^2 \lambda_{Pl}^2} \tag{2.5.19}$$

or

$$k'^2 = \frac{k^2}{\left(1 - \frac{v^2}{c^2}\right)} \quad (\hbar \ll 1) \tag{2.5.20}$$

or

$$\lambda' = \lambda\sqrt{1 - \frac{v^2}{c^2}} \qquad = \gamma^{-1}\lambda \tag{2.5.21}$$

So, we have delivered the phenomenon of the Lorentz-Fitzgerald length contraction by the U_μ field upon the Anderson-Higgs interaction.

Thus the entire relativistic dynamics follows from the model presented in this paper.

2. 6. ONSET OF THE EINSTEIN GRAVITY AS A GAUGE CONDITION

It is quite known but not quite discussed that the metric $g_{\mu\nu}$ and the Ricci $R_{\mu\nu}$ are not quite mutually compatible. The best and the most powerfully evident case being that of the blackhole where the increasing curvature causes the metric to break down. When the Ricci curvature is high, the metric becomes inextensible or breaks down. On the other hand, when the Ricci curvature is almost not there or say, the spacetime is Ricci flat, the metric is perfectly defined unless the manifold itself is C^2 or C^3 class and hence is discontinuous or has holes in it, made to remove the singularities. The best case of a scene opposite to that of the blackhole situation is that of the locally Lorentzian spacetime or a Wick-rotated Euclidean spacetime where , the metric is one of a straight line geodesy and the Ricci curvature – zero. We put this succinctly in the form of a Volterra model, as

$$\frac{\partial \mathcal{H}_A}{\partial t} = k^a_{AB}\mathcal{V}_B \tag{2.6.1}$$

with

$$\mathcal{H}_A = \begin{pmatrix} g_{\mu\nu} & 0 \\ 0 & R_{\mu\nu} \end{pmatrix} \ and\ \mathcal{V}_B = \begin{pmatrix} g_{\mu\nu} & -R_{\mu\nu} \\ -g_{\mu\nu}R & g_{\mu\nu}R \end{pmatrix} \tag{2.6.2}$$

The relevant equations are then

$$\frac{\partial g_{\mu\nu}}{\partial t} = k_{11}g_{\mu\nu} - k_{12}g_{\mu\nu}R \tag{2.6.3}$$

and

$$\frac{\partial R_{\mu\nu}}{\partial t} = -k_{21}R_{\mu\nu} + k_{22}g_{\mu\nu}R \tag{2.6.4}$$

Choose $k^a_{AB} = \sigma^a_{AB} - the\ Pauli\ spin\ matrices.$

Choose a gauge in which $\mathcal{H}_A(t) = const.or\ 0$ for $a = y\ and\ a = z\ in\ \sigma^a_{AB}$ or the gauge: $k^a_{AB} = \sigma^a_{AB}\ for\ a = x\ and = 0\ for\ a = y\ and\ a = z$

then,

$$\frac{\partial \mathcal{H}_A}{\partial t} = \sigma^x_{AB}\mathcal{V}_B \tag{2.6.5}$$

Imposing the above conditions, and the Ricci flow to take the physical process of diffusion of curvature into consideration

$$\frac{\partial g_{\mu\nu}}{\partial t} = -2R_{\mu\nu}(g) \tag{2.6.6}$$

we get

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = 0 \tag{2.6.7}$$

and

$$R_{\mu\nu}(t) = R_{\mu\nu}(0)e^{-t} \tag{2.6.8}$$

where $R_{\mu\nu}(0)$ is the Ricci tensor at initial value of the time and since the timelike geodesics are closed in the Planckian era due to the apparent Lorentz symmetry breaking in our model, there is no singularity involving any or all spacetime in the initial value of time.

In the above Pauli gauge, the unphysical mode of (quantum) gravity is (gauge) transformed away. The original unphysical mode is a causal condensate, the true vacuum of gravity with the diffusion of curvature given by eq (2.6.6), is acquired by the presence of the $K - field$. The fact that the other modes corresponding to $k_{AB}^{a} = \sigma_{AB}^{a}\ for\ a = y\ and\ a = z$ are unphysical can be seen by opening up the eq (2.6.1) or (2.6.3) and (2.6.4) and using the $k_{AB}^{a} = \sigma_{AB}^{a}\ for\ a = y\ and\ a = z$ as well observing that they don't concurr with the Ricci flow to deliver the Einstein field equations. Also, the $SU(2)$ symmetry used here has a holonomey structure also SU(2). So, it is possible that the vacuum configuration of our Hamilton-Volterra gravity is a $\mathbb{K}3 - surface$ – a Calabi-Yau $\mathbb{C}^2 \equiv \mathbb{R}^4$ manifold that is a vacuum configuration of the $SU(2)$ holonomy. And from the entire discussion of our model in this paper, it seems clear that this Calabi-Yau manifold is compactified since GR ceases to function below the Planck scale and the Universe under cosmological conditions is in this scale range. So, the above algorithm gives a mechanism for *"decompactification"* which indicates that the $\mathbb{K}3 - surface$ opens up into a spacetime manifold. Just a possibility. The gauge field $W_{\mu\nu}$ and a pure gravity (matter free) part given above accounted by the Pauli gauge fixing of the Hamilton-Volterra system of equations is accounted for by the above discussed Weinberg Hamiltonian. The relevant gauge group is then $SU(2)\otimes SU(2)/\mathbb{Z}_2$ gauge theory. This is precisely the group $SO(4)$. The acquiring of positive entropy and positivity of the mass given by the Higgs field makes the time physically asymmetric and the group $SO(4)$ Wick rotates to $SO(3,1)$.

3. CONCLUSIONS

At some point, one should ask where is physics and especially standard model physics going. Taking Einstein's theory of gravitation as something standard and ramifying around it and calling it a unified theory of everything and failing to make contact with the standard real world successfully verified physics or taking GRT itself as the base and attempting to quantize it by Hamiltonian methods with no background, hence non-perturbatively, and then ending up with no proper scalar and vector constraints but only candidates and then in the coarse graining limit failing to deliver GRT and thereby losing sight of the point from where one started are all signs of a failing physics. This is because no one has taken critical view of physics that has passed by but instead gone ahead building newer and newer structures on the successful ones built by the predecessors. This is a new trend of highly wishful mathematical thinking especially in cases where, those certain manifolds are claimed as physically real compactifications of the extra dimensions just because because they are the vacuum configurations of a certain holonomy group somewhat "physically relevant" here. The Einstein law of gravitation strictly speaks about dynamics and relativistically, this is limited. So, the quantum endeavor should try and answer the question of how's and why's of the phenomenon of dynamics. The covariant theory of gravitation prevents any classical object from going to the past. Thus, even the universe is also expanding ceaselessly. This kind of temporal asymmetry should not just be likened to the thermodynamic arrow of time as arising due to entropy, but efforts should be made to understand the same from a fundamental point of view…more so reverse arguments should be used if necessary as is done at the beginning of this paper to arrive at entropy as a fundamental quantum property giving the degree of randomness to every particle and every field and all in the universe and to the universe itself. When this is done, it is found that there is a field that gives entropy, i.e., a field that endows everything with which it interacts, a degree of randomness, and a static gauge field that upon interacting with this entropic field becomes dynamical and upon interacting with Higgs, becomes finitely dynamical. Some of the old wisdom such as the C-field concept of Hoyle comes alive when the properties of the entropy field are considered as a charge. The energy density of this C-field is found to be negative so that in the standard physics lore ever increasing entropy, spontaneity of the physical processes that cause this increase and the expansion of the universe that is likened to and said verbose to be related to the entropy law, well: they all come under the same roof. There is no need for any special dark energy to account for the anomalously small cosmological constant. And nothing new is concocted, either physical or mathematical, to increase the headache of the poor physicist and the philosopher just because it is aesthetically pleasing or sociologically and theologically appealing. Lorentz symmetry can be broken. That has been shown. Entropy is a charge. This has been systematically argued in this paper and also shown to be rightly so for the case of the blackholes by Wald [8]. The more fundamental origin of dynamics and its parent – the degree of randomness are investigated and one gets the scalar entropy endowing field and the vector dynamics endowing gauge field that, initially being a static gauge field, acquires entropy and mass through the entropy field and the Higgs field respectively, and then delivers limited dynamics to everything in the universe and the universe itself. Finally, we list pointwise some observationally and experimentally amenable properties and facts as well as conclusive experimentally viable features of our model discussed in this paper:

- One important point or rather an experimental test for verification for the basic premise of our model: we have said that every particle gets a random degree of freedom and becomes dynamic by virtue of the entropy K-field. If the photon gets this entropy then by our initial argument, it is highly possible to lower its own temperature to absolute (0K). Then at this absolute zero temperature of the photon, the entropy of the photon should tend to zero. If this, indeed, happens; the photon will lose its degree of randomness. It will then lose its dynamics and become static – come to a rest. Also, since the dynamics of the photon is limited, in that, it has a finite velocity, it should interact with the dynamic gauge boson U_μ or in the manner of the U_μ, its field should interact. This should endow it with a certain minimum mass – the rest mass. Thus,
- A photon should come to a rest at its absolute zero of temperature.
- A photon should possess a rest mass, however tiny; nevertheless, it should possess it.
- The objective of attaining an absolute self-temperature for the photon can be made possible by trapping it inside a Bose-Einstein condensate (using say, magneto-optic traps).
- The dynamics endowing gauge field U_μ can be detected say, by particle detectors in the LHC when the latter is modified. The mass of U_μ, predicted above, can in that case

be verified. Actually, this is the most direct evidence which is at the same time, also the most tedious and difficult.

- Upon the Higgs interaction of the gauge field U_μ, the gauge symmetry breaking has imminently occurred. This corresponds precisely to the redeliverance of the lorentz symmetry. This explains possibly why the gauge fixing in the Hamilton-Volterra model and the physical logic of the application of the curvature diffusion in the form of the Einstein field equations of pure gravitational (matter free) GRT.
- The Weinberg gauge field U_μ thus, has in the broken Lorentz symmetry, only the spin 2 field quanta interacting independently and then the spin 0 and 1 part come and join it upon the explicit breaking of the symmetry that opens the time-like geodesic fields as well as the limited dynamics is endowed to the Weinberg gauge field U_μ thereby rendering time asymmetrical and amenable to the rules of relativistic mechanics such as dilation and and to the consequences of GR such as warping, curving, etc.
- Ultimately, the K-field gives entropy and not its quantum the Clausion just as the Higgs field gives mass and not the Higgson. Also the K-field gives a degree of randomness. The Weinberg boson mediates dynamics and self-interacts due to its interaction with the K-field and then only itself becomes dynamical. Its interaction with the Higgs field makes it heavy and consequently the dynamics mediated by it becomes limited. Since, the scale is Planck scale and the mass acquired by the boson is the Planck mass the limit on the dynamics in vacuum spacetime is the velocity of light – c.
- One, very important thing to note is that the graviton part of the Weinberg quantum hamiltonian fields is independent of the Weinberg gauge field and hence still possibly massless so that it need not be bent by gravity or its constituent part – time. Thus, gravity can transcend time.
- Finally, we highlight the result that shows how time becomes relativistic: The above model is the physical basis of time asymmetry, since

  $\int_{\partial\Sigma} U = \Gamma = t \quad after\ K + Higgs\ interaction$

  and

  $\int_{\partial\Sigma} V = \Gamma = t \quad before\ Higgs\ interaction.$

Thus, the acquiring of mass by U_μ, makes time heavy as well which is the physical reason for time dilation since mass also varies similarly with velocity. So, more clearly, in the face of relativistic explorations, time and mass should vary relativistically in the same way. Thus, in the Galilean frame S' relative to the frame S, $t = \gamma t_0$ just as $m = \gamma m_0$. In the gap between the $K - field$ and the Higgs interaction, time is isotropic and is not heavy so that there is no limit on the velocity of light, although the concept for the techniques amenable to the perfectly manageable quantum field theory is still valid. The gap as it turns out is just the Planckian gap.

- You see, Einstein's law of gravitation clearly states that *every object follows a geodesic in the four dimensional spacetime continuum unless it undergoes collisions or unless it is acted upon by electromagnetic forces.* So, a quantum theory of gravity is not just a theory of gravitons and their interaction with matter quanta; it also a theory of the generation of dynamics – of action – of the beginning of the universe and of the diffusion of the gravitons in the Hamilton-Volterra $SU(2)$ gauge fixed mode to yield the vacuum Einstein field equations.
- The Higgs interaction gives a positive mass to U_μ. So, the dynamics is confined in time and the entropy keeps on increasing so the dynamics in its very nature is a temporally asymmetrically occurring one.
- And, we have discovered the possibility of **spontaneous bisymmetry breaking** – two symmetries of the same group broken in stepwise fashion of which the first one is essential for the endowment dynamics itself and the second is to impose (relativistic) limit on this acquired dynamics.

As we stated in the beginning, we considered bits and pieces here and there and tied them up to get the above concluded full picture, well… more or less…..

This is a physical model that envisages the physical foundations of dynamics, the relativistic limit on the dynamics, the relativistic nature of time, the physical basis of time asymmetry and the nature of gravity and the place of gravity in all these things happening together. All these investigated within in the fundamental principles of the framework of Quantum Gauge Field Theory.

Acknowledgement

The author wishes to thank Prof. Dr. Tomasz Borowski for his kind help and encouragement. He further wishes to thank Mr. Deepak Jaiaswal for technical assistance. He wishes to thank Prof. Dr. Michael E. Fisher, University of Maryland, for exposing him to the wonderful world of the Wilsonian Renormalization Group and the RG flows and the concomitant theory of the second order phase transitions and the renormalized Wilson-Fisher fixed point that corresponds to the peaked point in the lambda transition observed universally. Thanks are also due to Prof. Dr. Jeffrey D. Adams of the Math Department, University of Maryland, for teaching him some Lie groups and initiating him into the same. He also wishes to thank Prof. Dr. Graham Partis for his timely help and encouragement. Further, the author wishes to thank Prof. Prabhakar R. Hampiholi and the Chair of the Math Department Prof. Dr. Sudhir R. Jog, both of the Gogte Institute of Technology (GIT, Belgaum). To, Prof. Dr. Ravi S. Kulkarni (Professor of Mathematics, Bhaskaracharya Prathisthana, Pune, President of DST-NBHM and President of the Ramanujan Mathematical Society) for teaching him some extra fresh perspectives on geometry leading to Topological Dynamics. To Prof. Dr. A. K. Nandakumaran (Professor of Mathematics, IISc, Bangalore) are due thanks for teaching the author a complete course on Theory of Ordinary and Partial Differential Equations in a crash course. Finally, he wishes to thank his invaluable parents, Mrs. Supriya (Mamta) Ajit Kabe and Mr. Ajit Mangeshrao Kabe, for their undying love support and encouragement and their patience. Last but not the least, the author wishes to thank Prof. Dr. T. Padmanabhan for his wonderful pedagogical works in the form of such beautiful and lucidly readable books and papers, a few of these gems being cited here in the references.

Biography

Koustubh Kabe is Dr. Phil (PhD) / Sc.D. in Theoretical Physics. He has published several research papers investigating into the foundational issues of gravitational physics and the understanding of time and quantum gravity. He is also working on the problem of gravity and the cosmological implications in the framework of string theory. He is currently studying Quantum Measurement in addition to all of the above. His research interests are in the fields of General Theoretical Physics, Physical Mathematics, Theoretical Astrophysics, Theoretical High-energy Physics, Modern Theoretical Physics, Physical Cosmology, Geometric Analysis, Number Theory, Algebraic Geometry and lastly, Philosophy, Epistemology and Pedagogy behind Physical Theories. He is an author of a book titled "*Blackhole Dynamic Potentials and Condensed Geometry: New Perspectives on Blackhole Dynamics and Modern Canonical Quantum General Relativity*".

References

[1] Erik Verlinde, On the Origin of Gravity and the Laws of Newton, JHEP, 1104 029 (2009) [arXiv: hep-th/1001.0785]

[2] Koustubh Kabe, On Holography and Statistical Geometrodynamics, World Scientific News 30 (2016) 26-44.

[3] Koustubh Kabe. Geometry and Probability: Statistical Geometrodynamics with Holography, IYL, EJTP Spl. Issue on the Bohr-Einstein Debate, (December, 2015).

[4] T. Padmanabhan, Class. Quant. Grav. 21 4485-4494 (2004) [arXiv: gr-qc/0308070]; Mod. Phys. Lett. A25, 1129-1136 (2010) [arXiv: 0912.3165]; Phys. Rev. D81, 124040 (2010) [arXiv:1003.5665]; A Dialogue on the Nature of Gravity (2009) [arXiv:0910.0839]; Rep. Prog. Phys. 73, 046901 (2010) [arXiv: 0911.5004].

[5] Hugo Touchette, Simple Spin Models with Non-Concave Entropies, Am. J. Phys. 76(1), 26 (2008); J. Fernando Barbero G. and Iñaki Garay, Classical and Quantum Behavior of

Dynamical Systems Defined by Functions of Solvable Hamiltonians, Am. J. Phys. 76(2), 153 (2008).

[6] Robert M. Wald, The Thermodynamics of Blackholes, [arXiv: gr-qc/9912119v2] (2000).

[7] Stephen W. Hawking, Particle Creation by Blackholes, Comm. Math. Phys. 43 199-220 (1975); William G. Unruh, Notes on Blackhole Evaporation, Phys. Rev. D14, 870-892 (1976).

[8] Robert M. Wald, Blackhole Entropy is the Nöther Charge, Phys. Rev. D48, R3427-R3431 (1993).

[9] Steven Weinberg, Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity, (John-Wiley and Sons Ltd. 1972).

[10] Ignazio Licata in a private communication about and unpublished paper by Zizzi and Pessa.

(Received 18 May 2016; accepted 10 June 2016)