A theory with consolidation: Linking everything to explain everything

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Abstract

The paper reports a theory which gives explicit (ontic) understanding of the abstract (epistemic) mechanisms spanning many branches of physics. It results to most modern physics starting from Newtonian physics by abandoning progress in twentieth century. The theory assumes consolidation of points in 4-balls of specific radius in the universe. Thus the 4-balls are fundamental elements of the universe. Analogue of momentum defined as soul vector is assumed to be induced on the 4-balls at the beginning of the universe. Then with progression of local time, collisions happen leading to different rotations of CNs. For such rotations, the consolidation provides centripetal binding. By using general terminologies of force and work, the mass energy mechanism gets revealed. The theory provides explicit interpretation of intrinsic properties of mass, electric charge, color charge, weak charge, spin etc. It also provides explicit understanding of the wave-particle duality & quantum mechanics. Epistemic study of the universe with the consolidation results to conventional quantum theories. Elementary mechanism of the field interactions is evident due to conservation of the soul vectors, and its epistemic expectation results to the gauge theories. The theory predicts that four types of interaction would exist in the universe along with the acceptable relative strengths; it provides fundamental interpretation of the physical forces. Further, it explains the basic mechanisms which can be identified with dark energy & dark matter. It also results to (or explains) entanglement, chirality, excess of matter, 4-component spinor, real-abstract (ontic-epistemic) correspondence etc. The theory is beyond standard model and results to the standard model, relativity, dark energy & dark matter, starting by simple assumptions.

Keywords: Beyond Standard Model, Phenomenology, Relativity, Dark Matter; Realist Theory

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I. INTRODUCTION

Technically matter is the subset of space where energy is supposed to be trapped (signified) in form of certain properties which we assume while assuming the matter. Those certain properties are mass, electrical charge, spin, color charge, weak charge etc. Barrier in understanding of nature is lack of explanation of such intrinsic properties. The standard model (SM) assumes the intrinsic properties of particles arbitrarily; we have no explicit understanding about them. We don't even understand what a particle means really, understanding of particle as excitation of a field is highly abstract. Assumption of fundamental particles to be pointlike isn't logically consistent. When we have a possible model to explain existence of a thing with primary logic, then only one should assume the thing; because all of us strongly believe that 'we live in a universe that has all the characteristics of being created from nothing' [1,2] and it is well established that 'every element of the physical reality must have a counter part in the physical theory'[3]. For explanation of universe, we require three things- space, energy & matter. Assumption of matter is big trouble in theoretical understanding because assumption of matter implies assumption of about 37 particles of SM and additionally those for dark energy (DE) and dark matter (DM). Assumption of so many and special particles is not convincing to explain from the 'nothing'. It is spooky to say that before big bang nothing existed and after it, these particles came in existence with very specialized properties those we assume intrinsically (Indeed the quantum field theory (QFT) provides abstract understanding about some of the intrinsic properties, but it can't said to be explicit & is not for all the properties). Further, mass-energy equivalence implies that not matter but only energy and space should be basic ingredients of universe. For a consistent theory, it is needed to interpret the matter in pure geometric sense in terms of space & energy. Though Klauza-Klein type theories provide interpretation of some intrinsic properties, they do not answer fundamental questions like- what (& why) is mass? Further, they employ additional dimensions.

The theory which I am about to establish will explicitly explain many things like- how matter evolved from nothing as such? What the intrinsic properties due to? What is cause of fundamental interactions? and many more. In addition, it will provide simple and certain interpretation of quantum mechanics (QM) and thereby of SM. The theory gives fine connections with intrinsic properties, field interactions and quantum theories; it results postulates of relativity & QM (thus making abstract things explicit). It simply results to the conventional physical theories including SM and relativity.

II. CONSIDERATION SPACE & CONFIGURATION OF THE BIG BANG

Let the space of universe to be a 4-dimensional smooth manifold *M* locally having 3+1-dimensions i.e. locally there are three spatial dimensions and a parameter of evolution- time. We are going to assume that *points in very very small neighbourhood upto certain radius r (from the points) in M got consolidated resulting in the isotropic 4-balls*. In other words, fundamental geometric entities on the manifold *M* are not only points but also the 4-balls (open) of radius r.

The set of all non overlapping n-balls of constant radius is not a cover of n-dimensional space. Hence there are points on *M* which do not belong to any consolidated 4-ball. Hence there are two types of fundamental entities on *M*:- the *4-balls* where consolidation and the *points* where no consolidation occurred. The set of consolidated 4-balls is complement of set of unconsolidated points in *M*, thus the 4-balls can move in *M* and so the unconsolidated points exchanging corresponding positions. Basically, the points just aid mathematical configuration (i.e. mapping by the chart) and their movement may not be manifested physically; but the 4-balls would indeed lead to physical manifestation due to the distinguished consolidation that would induce many characteristics and are evident to be moving in *M*.

As the consolidation occurred at the instant of the big bang or it is by default, it occurred in the circumstances where nothing exists. Therefore the space within the consolidated spheres (4-balls) of radius r is Euclidean. This generates a general mathematical skeleton as:- space of the universe is a 4-dimensional smooth manifold *M* and there are plenty of Euclidian consolidated 4-balls (hereafter referred as Consolidated Neighborhoods (CNs)) of radius r which are elements of *M* and can move in it. For analysis on *M*, the CNs are equivalent to points (centre of a CN has to be identified as the point representing the CN for mathematical analysis) i.e. a CN can be specified by set of coordinates in a patch, locations and relative positions of CNs can be signified by vectors in a patch in *M*, for characteristics on manifolds like metrics & curvature the CN and point have same consideration.

Note that this formalism preserves soul calculus of geometric structures:- as two neighboring CNs do role of neighboring points defining the tangent spaces when there is a CN neighboring other CN. Otherwise points neighboring the CN define tangent spaces. For motion of the CNs on *M*, the points on *M* define tangent space. Thus features of differential geometry are applicable here. Accuracy of calculus depends on the separation between neighboring points. Though in this formalism for two neighboring CNs such separation doesn't tend to zero, it is very very small; so smaller 2r will yield sufficiently accurate calculus. One may feel bothered about non-absolute accuracy of calculus here, but will soon come to know that strange phenomenon of quantum uncertainty should be caused by this.

The physical universe is made up of CNs & points. Recognize that any two distinct points in the configuration space can be separated by disjoint open sets as they belong to different open sets or open 4-balls and hence the space of CNs or *M* is Hausdorff.

As the CNs exists in *M*, they can move on *M*. Their motion can be characterized by a momentum type vector. Our second assumption is that-*the push was induced to such CNs at the beginning of the universe*. Let's define this vector push associated with the CN as 'Soul Vector'. In general mathematical sense this is not an assumption, but let it to be assumed for physics. The soul vector can be defined as the variation in spatial position (in the 3 dimensions out of the 3+1) of the object point with respect to infinitesimal evolution in the local parameter (the 1 dimension out of the 3+1). It is evident that the 1 dimension out of the 3+1 referred as local evolution parameter is nothing but the time.

After the Big Bang (or creation) the space of the universe can be classified in two types as- one where nothing exists and other where something that came from big bang (creation) exists. We just interpret that 'something' in form of CNs and its disturbance via the soul vectors. It is reasonable to expect the consolidation (CNs) due to the shock of energy while the creation.

The beginning is unique or the induction of soul vectors in the universe resulted only once. It is easy to show that in such universe, we get the law which is sufficient to give rise to physics: conservation of soul vector. For instance, in any frame net soul vector is constant.

Consolidation and subsequently induction of soul vectors was occurred as very first event in *M*. We postulate that the CNs are 4-balls of radius r spanning the four dimensions isotropically. But *M* is locally 3+1 dimensional having three isotropic spatial dimensions and one time dimension. Any variation in CN (i.e. change in soul vector or motion in *M*) will induce changes in local surrounding in *M*. By local in *M* we mean be sensed by open neighbourhood in *M*. Further, the CN itself will have time evolution (such as rotation) what is equivalent to the +1 dimension of *M*. Therefore locally in *M*, CN would exist as 3-dimensional projection in the spatial space with evolution being possible. In other words, though CNs are 4-balls due to isotropy at or before the creation, in *M* locally they exist as spatial 3-balls with a parametric (time) evolution.

Mathematical foundation about interpretation of vector quantity is developed in [4]. There it is proved that in an n-dimensional configuration space, any vector entity comes in n types or versions having directions along corresponding ordered directions. Every number of dimensions of the configuration space comes with a type of ordered direction; for example, 1-dimensional with rectilinear & 2-dimensional with angular. As lower dimensional spaces can be embedded in higher dimensional one, in n-dimensional configuration space all the lower dimensional ordered directions exist. The path lengths along single type of ordered direction form a vector space; hence quantities along the ordered directions are vectors. Taking this forward, we define n-dimensional vector as the quantity in configuration space having direction along n-dimensional ordered direction. In the configuration space having number of dimensions n, an algebraic vector space having n'-dimensional vector elements has dimensions n+n'-1 i.e. therein can exist at most n+n'-1 mutually perpendicular n'-dimensional vectors. Elements of any algebraic vector space can be interpreted to have any type of ordered direction in configuration space if dimensionalities match. Alternatively, scalars along such ordered directions form exclusive vector spaces. In general, special parametric path along n-1 sphere leads to manifestation of n-dimensional ($n\neq1$) ordered direction. In this regard, continuous parametric (continuously varying solid angle being the parameter) path on 2-sphere leads to 3-dimensional ordered direction. We call the 3-dimensional ordered direction as 'sangular' direction. A vector quantity would exist in all the versions i.e. rectilinear, angular, sangular etc. We would call 1-dimensional, 2-dimensional & 3-dimensional vectors respectively as rectilinear, angular & sangular vectors. In the case where configuration space is 4-dimensional :- rectilinear vectors space has 4 dimensions, angular vectors space has 3 dimensions, and sangular vectors space has 2 dimensions (from the n+n'-1 rule). Indeed there exist 4-dimensional vectors having direction described along 3-sphere. But dimension of such vector space is just one. As 1-dimensional vector space has least analytical value as it is similar to the scalar set, the 4-dimensional vectors have no concern for vector analysis in 4-dimensional configuration space. All the versions of vectors have same algebra and algebraically one can't distinguish between them. The versions have geometrical difference realized when they are configured geometrically in a space or when the quantities exist along corresponding directions in the space of existence.

The theorem 6 in [4] implies that if an entity exists as a vector quantity in 4-dimensional configuration space, then it essentially exists in all the 4 versions of vectors, and induces same dynamics with all the versions. Hence assumption of induction of soul vector on a CN implies induction of all the four versions of it on the CN. We have ruled out the 4-dimensional vectors, hence we abandon this version of soul vector in this paper. Thus in the 4-dimensional configuration space *M*, soul vector exists (or induced while the creation) in versions of rectilinear, angular and sangular. In order to be more specific for the discussion, let's call the angular version of soul vector induced at the creation be spacetime angular soul vector. In the universe having unique beginning, the soul vector in all versions should be conserved.

In order to accommodate a version of vector, the object should be infinitesimally piecewise so. Most general objects are infinitesimally piecewise rectilinear, hence they can accommodate rectilinear vectors only. For accommodating higher dimensional vectors, the object is needed to offer infinitesimally piecewise corresponding ordered directions; this is possible only if the objects are higher spheres. The space *M* being a general manifold, is infinitesimally piecewise rectilinear only. Thus general open neighborhoods (or patches) in *M* can accommodate rectilinear vectors only and not other versions of vectors. The CNs are 4-balls i.e. they are 3-spheres offering infinitesimally piecewise angular & sangular directions; and hence CNs can accommodate angular & sangular vectors. Conclusively- on general neighborhoods or patches in *M*, only rectilinear vectors exist while on the tiny CNs other types of vectors can exist.

The CNs got induced three types of soul vector at the beginning. Out of them, the rectilinear version exists on general *M*. The rectilinear soul vector characterizes motion of CNs on *M*. While the angular and sangular soul vectors just remain as induced angular & sangular variations on the CNs.

The vectors in this manuscript will be rectilinear by default, otherwise will be specified. Recognise that all the geometrical versions of vectors are algebraically same; therefore algebraically the term vector is general, and applicable to all the versions. Also, in this manuscript repeated sum is implied over Greek or lowercase roman indices only.

III. GENERALIZATION OF FORCE & WORK

We can explicitly proceed with keeping in mind that the soul vector **s** is generalization or analogue of momentum in local frame. Each CN has associated certain **s** (in each vector version) due to the creation. Consider the tangent space at a point on *M*. Conservation of soul vector w.r.t. local time t implies $\frac{d\mathbf{s}}{dt} = 0$. If this **s** is changed then it is certainly due to a cause to be accounted. The cause of change of **s** (call as the Cause) is directly proportional to violation in conservation expected i.e. time rate of change of **s**.

$$\text{i.e. } \mathbf{f} = k\frac{d\mathbf{s}}{dt} \tag{1}$$

Where, k is some constant; and the Cause **f** is interpreted as generalization of classical force. Due to similarity of all the CNs the constant k should be universal constant.

When a soul vector is changed, then work must be done. The work is property to generate a Cause causing the displacement (or vice versa). Work done by the Cause should be proportional to magnitude of it and the displacement it caused. By the well established dot product analogy, we have to expect

$$W = \mathbf{f}.\mathbf{x} = k\frac{d\mathbf{s}}{dt}.\mathbf{x} \quad (2)$$

Where **x** is the displacement caused due to **f**.

IV. EVOLUTION OF PARTICLE

The structure inside the CNs is Euclidian. The structure is undergoing evolution which can be configured in terms of evolution parameter- time. Let us configure soul vector kinematics in local frame of a CN.

A. Collision of CNs

The CNs can move on *M* and hence they can collide. Consider one such collision as shown in fig.1. A CN centered at D is colliding with other one. While colliding, fraction of soul vector of each CN acts on other. In fig.1 fraction **SP** of external soul vector (i.e. soul vector of other CN) is acting at site of collision P which is a point on surface of the CN. A soul vector would be transferred to D (hence to the CN) if D is on its line of action. Let **s** and $\mathbf{s}_r$ respectively be tangential and radial components of soul vector **SP** w.r.t. sphere centered at D. Thus $\mathbf{s}_r$ will get added to original soul vector of the CN under consideration. Remaining **s** can't arithmetically affect original soul vector of the CN. Consolidation of the points in CN providing centripetal binding and **s** acting tangentially give rise to rotation of the CN.

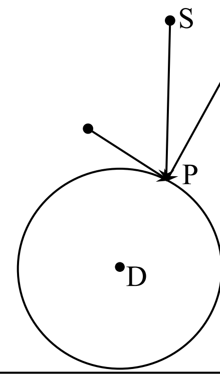

FIG.1: An external soul vector **SP** acting on a consolidated neighborhood centered at D

B. Energy trapped in rotation

Consider the case when the CN is rotating. Let **r** be position vector of the collision site P in the internal frame of the CN (fig.2) & its angular position at time t is ωt where ω is the angular velocity. t is the time (evolution parameter) measured from instance of collision. Considering **i** & **j** be Cartesian basis vectors in plane of rotation shown in fig.2, **r** & **s** being orthogonal

$$\mathbf{r} = r[\cos(\omega t)\mathbf{i} + \sin(\omega t)\mathbf{j}] \quad (3)$$

$$\& \ \mathbf{s} = s\,[-\sin(\omega t)\mathbf{i} + \cos(\omega t)\mathbf{j}] \quad (4)$$

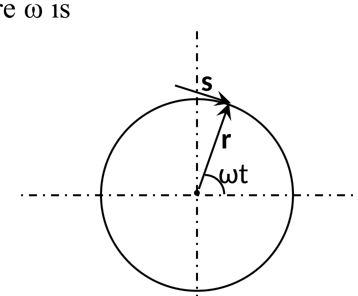

FIG.2: Tangential **s** trapped on surface & position **r** of site of collision at time t.

Thus, $\dfrac{d\mathbf{r}}{dt}$ = rω[−sin(ωt)**i** +cos(ωt)**j**] (5)

Once the rotation starts, it is uniform circular motion and no further work is done. All the work is done at the instant of collision, as there is sudden (& complete) change in soul vector of P. In order to calculate the work, we need to compute the Cause **f** at instant of collision and the displacement it causes. The Cause, from (1) is

$$\mathbf{f} = k\lim_{t\to 0}\frac{\mathbf{s}(t)-\mathbf{s}(t=0)}{t} = k\lim_{t\to 0}\frac{s\left[-\sin(\omega t)\,\mathbf{i}+\cos(\omega t)\,\mathbf{j}\right]-0}{t}$$

It is evident that **s** = 0 at t = 0.

$$\text{i.e. } \mathbf{f} = k.\frac{d\mathbf{s}}{dt} = k\lim_{t\to 0}\frac{s\left[-\sin(\omega t)\,\mathbf{i}+\cos(\omega t)\,\mathbf{j}\right]}{t} \tag{6}$$

The work formula (2) can be modified as-

$$W = k\frac{d\mathbf{s}}{dt}\boldsymbol{.}\boldsymbol{v}\,dt$$

Where ***v*** is velocity of P and time *dt* is the time of interest till which the work done is calculated. As the rotation lasts for unpredictable time, it is good to account for instantaneous energy trapped in rotation.

$$\text{i.e. } E = k\frac{d\mathbf{s}}{dt}\boldsymbol{.}\boldsymbol{v} \tag{7}$$

The velocity ***v*** can be expressed in terms of polar vector coordinates in the frame as

$$\boldsymbol{v} = \frac{d(\mathbf{r}\,.d\boldsymbol{\theta})}{dt} = \frac{d\,\mathbf{r}}{dt}.d\boldsymbol{\theta} + \mathbf{r}\,.\frac{d^2\boldsymbol{\theta}}{dt}$$

We are interested in the quantity at the initiation of the rotation. Thus the terms including $d\theta$ in this expression should be concerned at $t \to 0$ condition. Then the second term vanishes because at the instant just rotation started, change in $d\theta$ is zero. Thus by using (5)

$$\boldsymbol{v} = r\omega\left[-\sin(\omega t)\,\mathbf{i}+\cos(\omega t)\,\mathbf{j}\right].d\boldsymbol{\theta}$$

As this expression is at $t \to 0$ condition, in detail-

$$\boldsymbol{v} = \lim_{t\to 0} r\omega\left[\ -\sin(\omega t)\mathbf{i} + \cos(\omega t)\mathbf{j}\right].\Delta\boldsymbol{\theta} \tag{8}$$

Where, $\Delta\boldsymbol{\theta}$ is finite rotation in time t. Now, by (6), (7) & (8)

$$E = \ k\lim_{t\to 0}\frac{s\left[-\sin(\omega t)\mathbf{i} + \cos(\omega t)\mathbf{j}\right]}{t}\,.\lim_{t\to 0} r\omega\left[\ -\sin(\omega t)\mathbf{i} + \cos(\omega t)\mathbf{j}\right].\Delta\boldsymbol{\theta} \tag{9}$$

s, r & ω aren't functions of t. Obtaining dot product in terms of basis & utilizing a trigonometric identity,

$$= \ k\lim_{t\to 0}\frac{\Delta\theta}{t} sr\omega$$

All the terms in the limit are constants except $\Delta\theta$; and limit of change of angular displacement w.r.t. infinitesimal time at starting of rotation is nothing but the angular velocity i.e. ω. Thus finally we get

$$E = krs\omega^2 \tag{10}$$

This E is instantaneous work done in rotation (in fact it is derived at instant of induction of rotation, but due to the conservation, it is same at every next instant till ω is constant) i.e. energy felt when one probes the CN. ω is angular velocity of rotation which is constant and same for both **s** & **r** since they are always transverse. This angular velocity can be expressed in terms of linear velocities because **r** & **s** follow circular change as given in (4) & (5). Let linear velocity of site of collision w.r.t. centre of the CN be v' and similarly v" be that of tip of **s** w.r.t. its tail. Thus,

$$\omega = \frac{v'}{r} = \frac{v''}{s} \tag{11}$$

Substituting ω from (11) in (10),

$$E = kv'v'' \tag{12}$$

As magnitudes s & r constant for the rotating CN, their ratio is constant and thus so of v' & v".

$$\text{Let} \quad \mu = \frac{v'}{v''} = \frac{r}{s} \tag{13}$$

Thus (12) becomes $E = k\mu v''^2$ (14)

r is very small in magnitude which is the radius upto which consolidation occurred. Magnitude s is relatively larger as it is directly related with change of spatial position in unit time. With this information, from (11) one infers that v” is larger velocity than v’. The rotational velocity v” having higher radius for same angular velocity due to the smallest radius ought to be much higher than any velocity at (or about) the CN.

Condition of general covariance obliges to agree the measurements of same thing made by different observers (in this case observer is to be considered at CN). How the measurements at two isolated CNs are related? Distance can be measured or will result in terms of r and thus displacement measurements from distant or isolated CNs are agreed due to constancy of r. For time measurement, they do not have any reference time constant linked. We know the relation (11) and s should be much larger than r. Hence for any ω, v” is largest local velocity. It is convincing to say that time interval can be measured with reference to v”. v” being greatest velocity and knowing the distance measurement, every corresponding time interval can be sensed by treating v” as constant reference. This is the only way by which the agreement for time measurements at different CNs can be reached.

The rotating CN can be identified as a particle. The equation (14) is relating some characteristic of rotating CN i.e. μ, energy associated with this μ and square of largest reference constant velocity v”. This is exact mass-energy relation if we consider kμ to be mass of the rotating CN and v” to be velocity of light.

Defining $m = k\mu$ (15)

And identifying v” with c, we get famous equation- $E = mc^2$ (16)

We can believe on (15) because μ is consequence of existence of particle i.e. rotating CN. Further μ follows mathematics of mass m such as it is scalar. If two different CNs are considered to be united by a binding, then their resultant μ obtained from total energy E_1+E_2 is $\mu_1+\mu_2$. We will see ahead that μ follows all the properties and behavior of mass.

It is conclusion now that mass of particle is due to rotation of the CN which is caused by the consolidation and the tangentially trapped **s**. Difference in masses of particles is due to difference in ratios of rotation velocities of **r** to **s** (i.e. v’ to v” or c) or equivalently ratios of r to s, ultimately due to magnitudes of **s** associated. A consequential is that at every CN, velocity of tip of tangentially trapped & rotating **s** w.r.t. its tail has magnitude c.

It seems at a glance that with this scheme, time measurements at particles with different masses can not be agreed (remember relativity is alien so far) as they have different ω, hence it may not be allowed to treat c as largest velocity. But two identical particles must agree for time measurements; and for them treating c as largest constant velocity is only the option for the agreement. A CN makes (precisely results to) quantities in order to agree with measurements at identical (or at least- at same) particle. Hence c is maximum velocity and to be treated as constant in every particle frame. In order to preserve the covariance, there is no option/mechanism other than to treat c (i.e. v") as largest constant velocity.

V. WAVE PARTICLE DUALITY

Interpretation of wave particle duality is perhaps biggest issue of debate among scientific community. Yet there is no explicit interpretation of this duality and hence that of QM is obtained. Let us consider motion of the particle in *M*. In this section, differential motion in tangent space on *M* is to be considered. I want to keep the notations simpler as long as possible. Thus the tensor notations will be avoided where unnecessary.

A. The duality

Consider a particle (what is a rotating CN) moving in space *M* with certain velocity v. Thus the site of collision is simultaneously rotating and translating and traces a periodic curve on *M*. In the tangent space T_x of a point x (i.e. of the CN) on *M*, wavelength can be obtained as $\lambda = vT$, where T is period of rotation, and v is velocity along the path in T_x. The period T is given by $2\pi/\omega$. Thus,

$$\lambda = 2\pi v/\omega \tag{17}$$

From (11) & (13) $$\omega = \frac{\mu c}{r} = \frac{c}{s} \tag{18}$$

It gives $$\lambda = \frac{2\pi v r}{\mu c} = \frac{2\pi v s}{c} \tag{19}$$

Or $$\lambda\mu = \frac{2\pi v r}{c} \tag{20}$$

On LHS of (20) there is a wave characteristic (λ) & a particle characteristic (μ) while on RHS there are constants & a measure of motion (v). It implies that a moving particle can be referred as a wave of corresponding wavelength along same trajectory.

Making RHS of (20) total constant requires combining v with either wave property or particle property. Let us combine it with particle property by defining

$$b = \frac{m}{v} = \frac{k\mu}{v} \tag{21}$$

$$\therefore b\lambda = \frac{2\pi kr}{c} \qquad (22)$$

By the De Broglie hypothesis we know that multiplication of wavelength and the property of particle associated with its existence & motion (i.e. mass & velocity) gives a constant. (22) relates same but in different way. Here instead of particle property mv, the m/v is seen. Later we will see that De Broglie hypothesis is a special case of (22).

B. Kinetic energy of particle

A moving article has kinetic energy due to the velocity. In the tangent space of the particle, kinetic energy is given by classical expression. Thus kinetic energy of moving particle can be obtained as

$E_k = \frac{mv^2}{2} = \frac{bv^3}{2}$ Putting b from (22)

$$E_k = \frac{\pi.krv^2}{c}\nu \qquad (23)$$

For the particle moving with velocity c,

$$E_{kc} = \pi krc\nu \qquad (24)$$

This shows that energy of such particle or matter wave with velocity c is directly proportional to & depends only on its frequency. This is reminiscent of famous equation that established Plank constant.

C. Plank constant

Coincidently we have encountered through (22) & (24) both the analogs of key constant of nature i.e. Plank. Conventional duality is between momentum & λ, thus obtaining $p\lambda$ by using (15) & (20)

$$p\lambda = \frac{2\pi.v^2rk}{c} \qquad (25)$$

We moved towards Plank law by putting v=c in general relation (23). Thus by doing same in (25) we get

$$p_c\lambda = 2\pi rkc \qquad (26)$$

This states that for v=c, $p\lambda$ is certainly constant. De Broglie hypothesis is clearly based on only the v=c case, thus RHS of (26) is certainly Plank constant h. Hence

$$h = 2\pi rkc \qquad (27)$$

D. Mass-frequency relation and rest energy

We can calculate unknowns in (27) giving

$$kr = 3.517672204 \text{ x } 10^{-43} \text{ Js}^2/\text{m} \tag{28}$$

This value is useful for doing calculations such as of mass.

Substituting for λ & b in (22) we get $m = \dfrac{2\pi.kr}{c}\nu$ (29)

(29) makes it clear that in wave consideration energy is due to frequency while in particle consideration it is due to mass. With this, one can calculate mass of the particle, if frequency of same wave is known or vice versa. With this, rest energy (E_R) of a particle i.e. mc^2 takes the form

$$E_R = 2\pi rk\nu c \tag{30}$$

Thus total energy of the particle by (23) & (30) is

$$E = \frac{\pi.krv^2}{c}\nu + 2\pi rk\nu c = \pi rk\nu\left(\frac{v^2}{c} + 2c\right) \tag{31}$$

When (31) is used for v=c case, sum E (i.e. E_{kc}+E_R) would exceed the energy given by plank law. Little concentration reveals that- energy of the particle travelling with c is its rest energy only, as suggested by (27) & (30). As long as proposed theory is correct (or in order to validate it) it is to be concluded that the kinetic energy of a particle with velocity c is zero. This implies that net acquired energy of a particle travelling with c is same as its rest energy. In other words- no energy is consumed for motion when the velocity is c. But note that this result is hybrid consequence of the theory & observation; observation being provided by the eshtablished Plank law. But at this stage of the theory, it seems to be generalization that no driving energy is required to travel with c.

VI. GRAVITY

The soul vector **s** trapped tangentially on the collision site changes with time as CN rotates as shown in fig.2. As soul vector of isolated system is conserved and **s** is instantaneously changing, there is demand of soul vector directed apposite to such change. Instantaneous violation of soul vector conservation in the internal frame of particle obtained from (4) is

$$\frac{d\mathbf{s}}{dt} = -s\omega[\cos(\omega t)\mathbf{i} + \sin(\omega t)\mathbf{j}] \tag{32}$$

Therefore in the tangent space, there is instantaneous demand of soul vector

$$d\mathbf{s} = s\omega[\cos(\omega t)\mathbf{i} + \sin(\omega t)\mathbf{j}] \tag{33}$$

The variation (32) is directed towards centre of the CN within the Euclidean frame of the CN; and (33) is opposite to it. Thus in order to conserve **s**, there is instantaneous demand of soul vector (33) along the line directed towards collision site from centre of the CN in the CN's frame. This demand would propagate along same line (precisely- the geodesic) in *M* from collision site till it is satisfied or balanced. In the tangent space or *M*, the unbalanced soul vector demand would be seem to be generated from the CN/particle. We can consider propagation of instantaneous soul vector demand (33) as motion of a soul vector demanding package on *M*. This package is satisfied by soul vector addition by a particle which can have this type of soul vector (i.e. rectilinear, not angular or sangular). As the soul vector is variation of spatial location with respect to infinitesimal evolution in local time, it is directly proportional to the velocity of the object. As more & more **s** demanding packages are received by a particle, it simultaneously receives velocity increments. As ω (due to mass as $\omega = \frac{\mu c}{r}$) of a particle is constant, the rate of generating the soul vector demanding packages, and hence rate of resulting velocity increments for a neighboring particle is constant which turns to be uniform acceleration. In summary, a massive particle attracts other particle with uniform acceleration (we discovered gravity absolutely). Thus a particle moving with uniform acceleration can be viewed as attracted by other constant mass, what is meaning of the equivalence principle of general relativity. Recognise that the frequency of receiving soul demanding package on a test particle (CN) increases with ω of the concerned particle and $\omega=\mu c/r$ says that same increases with μ. In other words gravitational attraction on neighboring particle increases with mass of the particle.

This introduces (pseudo) Riemannian geometry on *M* as it makes possible to represent the attraction due to masses (gravity) by the metric tensor. That is, we come to know that *M* (till now which was a general smooth manifold) is a (pseudo) Riemannian manifold. Our discussion in sections IV-B & V clearly concluded that c is speed of light and is maximum attainable velocity, what is second postulate of special relativity. Further, a massive particle by soul vector demanding package pulls other CNs (or particles) following the geodesic in *M*. Thus we are lead to general relativity.

VII. UNCERTAINTY

General covariance is default condition for any scientific theory. Due to provision of postulates of special relativity and principle of equivalence, the proposed theory leads to the general relativity. Thus it is to be concluded that the manifold M is (pseudo) Riemannian manifold with locally Minkowskian geometry.

It is needed to reconfigure the consolidation considering space to be locally Minkowskian. Distance element in Minkowskian metric is given by $\left(\Sigma dx_j^{\;2} - c^2dt^2\right)^{1/2}$ where x_j are spatial coordinates under some coordinate chart. Very first assumption of this theory manifests consolidation of all points in neighborhood (of the points) of radius r in M. CN is 4-ball of radius r. Due to such consolidation and proposition that particles are manifestations of CNs, the possible separation between particles at different spacetime locations can't be smaller than 2r. Thus the possible distance between two CNs (we identify the CN with its centre for representation) on M is $\left(\Sigma dx_j^{\;2} - c^2dt^2\right)^{1/2} \geq 2r$. Hence we get minimum possible spatial separation as- $\Sigma dx_j = (4r^2 + c^2dt^2)^{1/2}$

If β is complementary of angle between minimum separation 2r between two CNs and time axis on spacetime diagram (recognize that β depends on velocities of the CNs), then minimum spatial and temporal intervals respectively are

$$\Sigma dx_j = 2r\cos\beta \tag{34}$$

$$\&\ dt = \frac{2r\sin\beta}{ic} \tag{35}$$

If one wants to get derivative of a function f w.r.t. time then it is not $\lim\limits_{\Delta t\to 0}\frac{\Delta f}{\Delta t}$ as minimum possible time interval is not about zero but $\frac{2r\sin\beta}{ic}$; hence actual derivative should be

$$\frac{df}{dt} = \lim_{\Delta t\to\Delta t_0}\frac{\Delta f}{\Delta t} \quad \text{where } \Delta t_0 = \frac{2r\sin\beta}{ic} \tag{36}$$

Similarly for derivative w.r.t. spatial variables,

$$\frac{df}{dx} = \lim_{\Delta x\to\Delta x_0}\frac{\Delta f}{\Delta x} \text{ where } \Delta x_0 = 2r\cos\beta \tag{37}$$

Here we get maximum possible infinitesimal space & time intervals as 2r & $\frac{2r}{ic}$ and minimums are about zero. They depend on β which depends on velocity of the CNs with respect to a constant frame or chart. Classical calculus assumes infinitesimal variations about zero, thus the minimum infinitesimal case is of the calculus. At a specific velocity (i.e. β) in a chart, both the infinitesimal separations are dependent on each other; hence we have to derive infinitesimal mathematics for general case i.e. concerning β.

Till now we considered internal frame of the CN. Now onwards we will consider the general frame specified by a chart on M and its geometry. Also, the uncertainty in measurement of a quantity j will be represented as Δ_{j}.

Moving ahead, we know that

$$\cos\left(\Delta t/2\right) < \frac{\sin\left(\Delta t/2\right)}{\Delta t/2} < 1$$

$$\therefore \lim_{\Delta t \to \Delta t_0} \cos\left(\Delta t/2\right) < \lim_{\Delta t \to \Delta t_0} \frac{\sin\left(\Delta t/2\right)}{\Delta t/2} < 1$$

$$\text{i.e.} \cos\left(\frac{r\sin\beta}{ic}\right) < \lim_{\Delta t \to \Delta t_0} \frac{\sin\left(\Delta t/2\right)}{\Delta t/2} < 1$$

Remembering order of magnitude of r, $\lim_{\Delta t \to \Delta t_0} \frac{\sin\left(\Delta t/2\right)}{\Delta t/2} \approx 1$. This limit equals one but approximately; uncertainty in the equality is the difference in the bounds

$$\text{i.e. } \Delta_{\lim\limits_{\Delta t \to \Delta t_0} \frac{\sin(\Delta t/2)}{\Delta t/2}} = 1 - \cos\left(\frac{r\sin\beta}{ic}\right) \tag{38}$$

$$\text{Next, } \frac{d}{dt}\sin t = \lim_{\Delta t \to \Delta t_0} \frac{\sin(t+\Delta t) - \sin t}{\Delta t} = \lim_{\Delta t \to \Delta t_0} \left[\cos\left(t + \frac{\Delta t}{2}\right) \frac{\sin\left(\Delta t/2\right)}{\Delta t/2}\right]$$

$$\text{i.e. } \frac{d}{dt}\sin t = \cos t \quad \text{with } \Delta_{\frac{d}{dt}\sin t} = 1 - \cos\left(\frac{r\sin\beta}{ic}\right) \tag{39}$$

Here we neglected the factor $\frac{\Delta t}{2}$ in $\cos\left(t + \frac{\Delta t}{2}\right)$ as it has negligible effect due to the additive nature.

$$\text{Similarly, } \frac{d}{dt}\cos t = -\sin t \quad \text{with } \Delta_{\frac{d}{dt}\cos t} = 1 - \cos\left(\frac{r\sin\beta}{ic}\right) \tag{40}$$

Noting that the chain rule is valid for such derivatives, and d(ωt)/dt = ω; from (3), on a chart in *M* in equivalent Cartesian frame of the rotation plane we get

$$\frac{d\mathbf{r}}{dt} = r\omega[-\sin(\omega t)\mathbf{i} + \cos(\omega t)\mathbf{j}] \quad \text{with } \Delta_{\frac{d\mathbf{r}}{dt}} = r\omega\left[\left[1-\cos\left(\frac{r\sin\beta}{ic}\right)\right]\mathbf{i} + \left[1-\cos\left(\frac{r\sin\beta}{ic}\right)\right]\mathbf{j}\right] \tag{41}$$

$$\text{i.e. } \left|\frac{d\mathbf{r}}{dt}\right| = r\omega \qquad \text{with } \Delta_{\left|\frac{d\mathbf{r}}{dt}\right|} = \sqrt{2}r\omega\left[1-\cos\left(\frac{r\sin\beta}{ic}\right)\right] \tag{42}$$

Considering this uncertainty in $\frac{d\mathbf{r}}{dt}$ in calculation of $\boldsymbol{v}$, and using it for deriving E we get

$E = krs\omega^2$

Using formula for uncertainty in product of uncertain quantities, uncertainty in E is

$$\Delta_E = \sqrt{2}krs\omega^2\left[1-\cos\left(\frac{r\sin\beta}{ic}\right)\right] \tag{43}$$

Equation (43) states that Δ_E is uncertainty in measurement of energy E. Recall how we concluded formula for energy in section IV-B. E is the work done in infinitesimal time. Now we know that in M infinitesimal time is nothing but Δt_0. To put it differently, Δ_E is amount of energy which can be violated within time Δt_0. This is principle of energy-time uncertainty in Minkowskian (real) space. Denoting time uncertainty by Δ_t and substituting for ω,

$$\Delta_E \,.\, \Delta_t = \frac{2\sqrt{2}}{i}krc\mu\left[1-\cos\left(\frac{r\sin\beta}{ic}\right)\right]\sin\beta$$

Substituting $h = 2\pi rkc$; $\quad \Delta_E\ \Delta_t = \sqrt{2}\frac{h}{\pi.i}\mu\left[1-\cos\left(\frac{r\sin\beta}{ic}\right)\right]\sin\beta$ (44)

This isn't the Heisenberg uncertainty relation, but it is good to know with the theory (without knowledge of quantum mechanics) that the energy can be violated in certain amount in certain infinitesimal (precisely near zero) time.

When we do analysis on *M* and not within the internal frame of a CN, the uncertainties are inevitable. Analysis within a CN's frame can not account other CNs as universe or the surrounding need not be Euclidean. The uncertainty depends on velocity of the CNs in a frame on *M*.

VIII. QUANTUM MECHANICS

A. Dynamics of expectation

Through section V, we came to know that a wave is associated with a moving particle on *M*. And at certain instant of time, the particle is at certain location. A curious physicist is interested in finding location of particle at specific time. If one knows span of a particle (i.e. space along which the wave is traced) in neighborhood of an instant, then he expects that the particle can be anywhere along the path (implied by the span) at the instant. There is a probability at each point about existence of particle at that point (precisely, in its neighborhood). Thus we are lead to a probabilistic expectation of particle along the path in *M*. The probabilistic study can be done by constructing a fiber bundle on base space *M* where fiber is a vector space to accommodate the probabilistic expectation. The probabilistic study can be well performed by considering rational constraints in general functional inner product space i.e. Hilbert space as the fiber space. In such general functional space, the probabilistic expectation function can be discovered. The probabilistic expectation function is related to the particle equivalent to a wave traced in *M*. For compatibility of both (i.e. expectation & reality), the function should have periodicity same as that of the particle equivalent wave. For discovering the probabilistic expectation function, we may make use of different expressions of energy associated. In this regard, attained or mechanical energy should be equal to expected energy for same entity. These simple constraints would help us to discover the corresponding expectation function.

Consider a local portion of *M* where time is local parameter of evolution. The probabilistic expectation function (let it be ψ) about prediction of a particle existence assigns probability density to every point. Integral of this function near neighborhood of a point in *M* should give probability of finding the particle in the neighborhood. If ψ is given by delta function $\delta_{\tilde{a}}^4 = \delta_{\tilde{a}}^4(x) = \delta^4(x - \tilde{a})$ with $\tilde{a} \in M$, it means probability of finding the particle at ã is 1. If this location isn't certain, then $\rho(\tilde{a})\delta_{\tilde{a}}^4(x)$ will give probability about particle existence at this point where $\rho(\tilde{a})$ denotes the probability at ã which is magnitude obtained from the probabilistic expectation function ψ at ã. Collective probability of finding the particle anywhere out of n spacetime points is $\rho = \sum_{i=1}^{n} \rho\left(x_i\right) \delta^4{}_{x_i}$

By $\delta_{\tilde{a}}^4$ we mean integral of $\delta^4(\mathbf{x} - \tilde{a})$ i.e. unit magnitude at ã; mathematically it is direct product of unit number with the points ã of *M*.

If one is concerned with probability of finding in certain spatial interval, then points being continuous in the interval we obtain probability of finding of the particle in interval I as

$$\rho_I = \int_I \rho(\mathbf{x}).\delta^3{}_{\mathbf{x}}\, d\mathbf{x} \tag{45}$$

Where, $\delta^3{}_{\mathbf{x}}$ is integral of delta function of spatial point **x** belonging to the spatial subset of *M* at the specific time. In the spatial or spacetime intervals, ρ is needed to be a continuous function.

Also, probability of finding the particle in a spacetime interval I' is

$$\rho_{I'} = \int_{I'} \rho(\mathbf{x}).\delta^4{}_{\mathbf{x}}\, d\mathbf{x}$$

Note that we are using ρ for general notion of probability, thus we haven't distinguished it for 3 & 4 dimensional cases. Expressions of the specific functions in such cases may vary. Let's focus now on the spatial location of the particle at fixed time i.e. concerning $\delta^3{}_{\mathbf{x}}$.

As the particle is certainly somewhere in local space at local instant, at every instant of time,

$$\int_{-\infty}^{\infty} \rho(\mathbf{x}).\delta^3{}_{\mathbf{x}}\, d\mathbf{x} = 1 \tag{46}$$

There will be different (but compatible) equations for three and four dimensional cases of spatial and spacetime expectations respectively i.e. for obtaining coefficients of $\delta^3{}_{x_i}$ & $\delta^4{}_{x_i}$.

Area under $\delta^3{}_{x_i}(x)$ is unity and $\rho(x_i) \leq 1$. Thus $\rho(x_i).\delta^3{}_{x_i}(x)$ signifies fraction $\rho(x_i)$ of $\delta^3{}_{x_i}(x)$ i.e. the probability fraction. This implies that the probabilistic expectation function can be written as linear combination of integrals of delta functions at every point. Work of Kryukov [5] suggests that delta functions form basis in Hilbert space which is general function space with inner product. Hence any function ψ can be written as linear combination of delta functions. Such Hilbert space would have vector structure with the set of delta functions at all points being basis and the probability at each point being magnitude in respective basis. As there are infinite points in any spatial (or spacetime) interval, basis of Hilbert space consists of infinite delta functions and hence ψ lives in infinite dimensional Hilbert space. (In this section, we are curious about location of the particle. If anyone is curious about other property such as momentum, then with same methodology corresponding Hilbert space can be constructed. If only few values (or positions) of the property are supposed to be taken by the particle, then the Hilbert space will have finite dimensions.)

It is obvious that ρ should be directly specified by ψ. In general, ψ can be negative while probability always needs to be positive. Also due to general functional analysis and Riemannian spacetime, ψ should be complex in general. Thus there is simple possible relation fulfilling these conditions-

$$\rho(x_i).\delta^3_{x_i} = \psi^*(x_i)\,\psi(x_i) \qquad (47)$$

Where, ψ^* is complex conjugate of ψ.

We are lead explicitly to probabilistic distribution function ψ (will derive Schrödinger& Dirac equations of it soon) that we know from century. But there is an obstacle in accepting that this formalism is same as that describes the quantum mechanics we know. The space of quantum mechanical states is space $L_2\left(\mathbb{R}^3\right)$ of Lebesgue square integral functions on $\mathbb{R}^3$ which do not contain delta functions. This problem is addressed in [6] according to which the Hilbert space obtained by completing the space $L_2\left(\mathbb{R}^3\right)$ in metric defined by the inner product

$$\left(\varphi_1,\varphi_2\right)=\left(\frac{L}{\sqrt{2\pi}}\right)^3\int e^{\frac{-L^2}{2}(x-y)^2}\varphi_1(x)\varphi_2(y)\,d^3x\,d^3y \qquad (48)$$

with positive constant L contains delta functions and their derivatives. Furthermore for sufficiently large L, the results of quantum mechanics in both the spaces are unchanged.

Thus with this scheme, it is convincing that our discussion is consistent with physics and leads to formalism of wave function of quantum mechanics.

The wavy nature associated with moving particle (due to simultaneous rotation & translation of the CN in *M*) as seen in last sections is real. Call this real wave as ontic wave. Additionally, the statistical attempt of the curious physicist results in expectation of probability density of finding which also is a wave as it is disturbance of probability amplitude along path of particle. Call this abstract but useful wave as epistemic wave. The epistemic wave ψ is capable and useful to interpret properties of ontic wave. If any abstract epistemic wave is used to explore properties of an ontic wave, then they both should have same periodicity. This ensures validity of equations of dynamics (to be developed in following sections) by making the constraint logical.

Such formalism is also valid when we use $\delta_{\tilde{a}}^4(x)$ to denote certain existence of the particle at general $x=\tilde{a}$ on *M*. Then the space $L_2\left(\mathbb{R}^4\right)$ completed by inner product similar to (48) forms general Hilbert space, refer [6]. Set of delta functions of all the points in *M* forms basis of such Hilbert spaces.

B. Schrödinger equations (SE)

Useful equations can be derived to get the epistemic function ψ. A couple of constraints is useful for this derivation. Epistemic function is to be used to extract information of the moving particle equivalent to the ontic wave. A change in ontic wave can be specified by corresponding epistemic wave only if they both have same periodicity to facilitate variations. Therefore the epistemic function should have periodicity same as that of the particle's ontic wave. This is straightforward scheme to consider existence of epistemic wave inherent to that of the particle. Then, mechanical energy must be same as the expected energy. With these two constraints, we can explore for ψ.

Total expected energy expression of a particle with velocity c is different than that for general velocities, as discussed in section V. Thus two separate equations for dynamics of particle with these velocities are to be obtained. Generally ψ ought to be complex thus we should start by considering general complex wave function (which also means that the fiber bundle to accommodate ψ on *M* is needed to be complex). For these derivations, initially we have to consider local patch on *M* i.e. space & time are independent variables for dynamics. Scenario for deriving the epistemic equations of dynamics is clear- An epistemic wave along path of a particle on *M* will be considered having same periodicity as the ontic one, and then energy of it in expected and mechanical expressions will be equalized.

1.Schrödinger equation for particle with velocity c

Consider the general complex wave function of periodicity same as that of particle's ontic wave: $\psi(\mathbf{x},t) = A.e^{i(k'\mathbf{x}-\omega t)}$; its derivatives w.r.t. **x** & t yield respectively

$$\nabla^2\psi = -k'^2\psi \tag{49}$$

and $$\frac{\partial\psi}{\partial t} = -i\omega\psi \tag{50}$$

Further, Mechanical energy in terms of k' = Energy expected in terms of ω

When this equality is multiplied by a function ψ, then it remains equality as at specific **x** & t the function is unchanged.

i.e. Mechanical energy, $E(k')\,\psi = E(\omega)\,\psi$, Expected energy (51)

Next, Putting wave number $k' = 2\pi/\lambda$ in (26), we get $p_c = k'krc$,

It gives $E_{kc} = \dfrac{p_c^{\,2}}{2m} = \dfrac{k'^2k^2r^2c^2}{2m}$

substituting for k'^2 from (49),

$$E_{kc}\psi = \frac{-k^2r^2c^2}{2m}\nabla^2\psi \tag{52}$$

This is kinetic energy multiplied by ψ, if there is some external potential V then total energy multiplied by ψ is

$$E\psi = \frac{-k^2r^2c^2}{2m}\nabla^2\psi + V\psi$$

We also know that for case of v=c, total expected energy of particle is hν i.e.2πrkcν= rkcω irrespective of surrounding potential. Thus substituting for ω from (50)

$$E\psi = rkc\omega\psi = irkc\frac{\partial\psi}{\partial t} \tag{53}$$

Hence equating Eψ in both representations we get Schrödinger equation.

$$\frac{-k^2r^2c^2}{2m}\nabla^2\psi + V\psi = irkc\frac{\partial\psi}{\partial t} \tag{54}$$

It is evident from (27) that krc= ħ, with this substitution we get familiar form of Schrödinger equation. By abandoning progress of physics in twentieth century, our theory is reaching to QM.

2. The two cases of velocities and observations

Dynamics for the velocity other than c has different nature. For v=c, p is in relation of duality while generally b is so. Further, for general velocity there is no Plank law on total expected energy of the particle.

When we put v=c in general relation (25), we got p.λ = constant. Also, by using energy relations for v=c case, we got well known Schrödinger equation. Following same methodology for general velocity case wouldn't yield the Schrödinger equation. Thus conventional quantum mechanics we know is a special case (v=c) of the general (Of course, key concepts underlying the QM i.e. De Broglie hypothesis and Plank law are clearly have special evidences for v=c case only). But before proceeding, it has to be clarified why the observations for v≠c condition can fall within predictions with the special case.

Consider a particle moving with velocity v≠c, let the difference be c-v = $\ddot{\upsilon}$ (55)

Thus (25) becomes $p\lambda = \frac{2\pi(c-\ddot{\upsilon})^2 rk}{c}$

$$\text{Or } p\lambda = 2\pi rkc + 2\pi rk\frac{\ddot{\upsilon}^2}{c} - 4\pi rk\ddot{\upsilon} \tag{56}$$

In case of the experiments of interest (i.e. those based on framework of conventional QM) $\ddot{\upsilon}$ is much smaller fraction of c, thus last two terms in above equation are relatively smaller. In other words above equation can be read as pλ = 2πrkc (what is h) with the uncertainty

$$\Delta_{p\lambda} = 2\pi rk\frac{\ddot{\upsilon}^2}{c} - 4\pi rk\ddot{\upsilon} = 2\pi rk\left(\frac{\ddot{\upsilon}^2}{c} - 2\ddot{\upsilon}\right) \tag{57}$$

Further, as λ=pλ/p,

$$\Delta_{\lambda} = \Delta_{p.\lambda} / p \tag{58}$$

Similarly, $\Delta_p = \Delta_{p.\lambda} / \lambda$ (59)

Here we neglected uncertainties in p or λ in denominator.

As a particle moves in *M*, it traces ontic wave. In frame of isolated particle, distance and time are to be measured referring its internal reference. We have seen that velocity of tip of **s** w.r.t. its tail is c. It can be interpreted that the measurements about the particle result by referring such velocity of tip of **s** w.r.t. tail is to be of magnitude c. Further, the displacement of particle is nothing but the number n of waves it traced multiplied by its wavelength λ. Number of waves traced is absolute, but measurement of wavelength has uncertainty (58) depending on velocity of the particle; λ is blurry while the number n of waves traced is certain. From relations like (22) & (26) we can get the wavelength indirectly. One can multiply such wavelength by n to get displacement of the particle. i.e. $x = n\lambda$ Hence uncertainty in measurement of λ turns in uncertainty in displacement x.

i.e. $\Delta_x = n.\ \Delta_{p.\lambda} / p$ (60)

multiplying (59) & (60) we get

$$\Delta_p \,.\, \Delta_x = \frac{n\Delta_{p\lambda}{}^2}{p\lambda} = \frac{n\left(2\pi rk\right)^2\left(\ddot{\upsilon}^2 - 2\ddot{\upsilon}\right)^2}{p\lambda c^2}$$

We also know that $p\lambda = 2\pi rkc$ with uncertainty $\Delta_{p.\lambda}$. Applying result of division by uncertain quantity,

$$\Delta_p\ \Delta_x = \frac{2\pi rkn\left(\ddot{\upsilon}^2 - 2\ddot{\upsilon}\right)^2}{c^3} \quad \text{with} \quad \Delta_{\Delta_p \Delta_x} = \frac{2\pi rkn\left(\ddot{\upsilon}^2 - 2\ddot{\upsilon}\right)^2}{c} \tag{61}$$

Here uncertainty in $\Delta_p\ \Delta_x$ is calculated by ignoring uncertainty in pλ in denominator for simplicity; more accuracy can be obtained by considering uncertainty in pλ every time.

As we have concluded $h=2\pi rkc$, (61) becomes

$$\Delta_p\ \Delta_x = \frac{hn\left(\ddot{\upsilon}^2 - 2\ddot{\upsilon}\right)^2}{c^4} \tag{62}$$

This means that for specific velocity, the product $\Delta_p\ \Delta_x$ is constant. For a system under study, lesser uncertainty in the knowledge of one increases the uncertainty in knowledge of other. Product of uncertainties (62) for typical high energy/velocity particles is much smaller than Heisenberg's uncertainty product. The uncertainty relation (62) depends on velocity of particle, but most of the experiments of quantum physics deal with the particles with velocity where $\ddot{\upsilon}$ is much smaller. Further, uncertainty Δ_p

Δ_x gets mixed with lack of knowledge of ΰ. It is also implied from (62) that the uncertainty increases with n i.e. distance of travel of the particle.

For most of the cases ΰ is much smaller. And hence the major uncertainty (57) is within range to give observed results. It is thus rational that conventional QM is v=c case of the general and though quantum mechanical experiments deal with particles having velocities different than c, the results get mixed with the uncertainties leading to acceptable results.

Thus we can obtain two types of equations of dynamics of particle. We are required to treat both the cases of velocity separately because expected energy of particle for these cases is much different. For general case, expected energy of particle is sum of all forms of energy i.e. $E_k+E_R+E_p$; but for v=c it is just h*ν*. And this relationship is to be exploited to get equations of dynamics. By special equation we will mean the equation of dynamics derived for v=c case, and is applied to general v≠c case (Technically, it is wrong to say that the equations applied to v≠c case as the velocity itself is unknown. This fact mathematically & scientifically allows us to apply the special equation generally). Thus it can give results for general velocities with corresponding uncertainties. By special equation we mean to account for planks law assuming velocity c and by general equation we mean to abandon the Plank law by bothering about general velocity.

It is important to note that the particles concerned so far are the fundamental particles. If these results are to be applied to composite particles like hadrons, meson, atoms etc. then modification is required. For instance, the epistemic wave traced by a composite particle would be resultant of those traced by its constituents.

3.Schrödinger equation for general velocity ≠ c

Now we should proceed to derive Schrödinger like equation of dynamics for general case. To do so, we will write down mechanical & expected energy expressions and will equate by multiplying the field ψ.

$$KE=\frac{p^2}{2m} \quad \text{and from (56), } p = k'krc+ k'kr\left(\frac{\text{ΰ}^2}{2}+2\text{ΰ}\right)$$

$$\text{Thus } E_k=\frac{k'^2k^2r^2}{2m}\left[c+\left(\frac{\text{ΰ}^2}{2}+2\text{ΰ}\right)\right]^2$$

$$\text{Substituting for } k'^2 \text{ from (49), } E_k\psi=\frac{-k^2r^2}{2m}\left[c+\left(\frac{\text{ΰ}^2}{2}+2\text{ΰ}\right)\right]^2\nabla^2\psi$$

Thus assuming that external potential can't be function of k' or ω

$$E\psi = \frac{-k^2r^2}{2m}\left[c+\left(\frac{\tilde{\upsilon}^2}{2}+2\tilde{\upsilon}\right)\right]^2 \nabla^2\psi \ + V\psi \tag{63}$$

To obtain expected KE in ω representation, we use (29) & get

$$E_k = \frac{krv^2\omega}{2c}$$

Thus substitution from (50) yields

$$KE\psi = \frac{ikrv^2}{2c}\frac{\partial\psi}{\partial t}$$

$$\text{Hence } E\psi = \frac{ikrv^2}{2c}\frac{\partial\psi}{\partial t} + V\psi \tag{64}$$

By equating Eψ in both the expressions (63) & (64), we get

$$\frac{-k^2r^2}{2m}\left[c+\left(\frac{\tilde{\upsilon}^2}{2}+2\tilde{\upsilon}\right)\right]^2 \nabla^2\psi \ + V\psi = \frac{ikrv^2}{2c}\frac{\partial\psi}{\partial t} + V\psi \tag{65}$$

$$\text{i.e. } \frac{-k^2r^2}{2m}\left[c+\left(\frac{\tilde{\upsilon}^2}{2}+2\tilde{\upsilon}\right)\right]^2 \nabla^2\psi = \frac{ikr\left(c-\tilde{\upsilon}\right)^2}{2c}\frac{\partial\psi}{\partial t} \tag{66}$$

Unlike v=c case, for general case Vψ vanishes. This is because external potential can't be function of k' or ω. For v= c, total energy is h*ν* irrespective of potential of particle; therefore in that case the equation is not symmetric in V. But in general case Vψ enters on both the expressions & gets cancelled. (66) is in terms of difference velocity $\tilde{\upsilon}$. Same can be obtained in term of v as

$$\frac{-krv^3}{2k'c}\nabla^2\psi = \frac{ikrv^2}{2c}\frac{\partial\psi}{\partial t} \tag{67}$$

This is expressed in terms of wave property k' and can be expressed in terms of particle property i.e. equivalent m by putting k' = mc/(vkr)

$$\frac{-k^2r^2v^4}{2mc^2}\nabla^2\psi = \frac{ikrv^2}{2c}\frac{\partial\psi}{\partial t} \tag{68}$$

These general equations are difficult to adopt in practice since they require knowledge of v. Remember that SE which we are familiar to is derived from de Broglie hypothesis which has strictly foundation of v=c case only. Thus (54) is SE of our knowledge. Further (54) leads to well known quantum theories. The QM we are familiar to, which is special- can be obtained if we proceed from (54). Here I choose to proceed from (68) now (instead of from (54)) just because proceeding from (54) will seem repetition of established expressions. Here we will come to know that this theory explicitly leads to assumptions of quantum mechanics. In following subsection we will explicitly lead to scheme of operators.

C. Operators

When we proceed with the dynamical equations (54) or (68) following the concept about dynamics of expectation as discussed in section VIII-A, we will explicitly lead to the operator mechanism. To exercise the route, I am going to proceed with (68) for general velocities. If one proceeds with (54), then she would get conventional (the special) quantum mechanics i.e. the case of dynamics of v=c case applied to unknown velocities.

Consider a local portion of *M* where time is parameter of evolution. In VIII-A we demanded ψ to describe probability amplitude of finding the particle. Thus ψ*ψ is probability function; therefore concerning (47), average value of **x** (i.e. expected position of the particle) is

$$\langle \mathbf{x} \rangle = \int \mathbf{x}\psi^*\psi \mathbf{dx} \tag{69}$$

Next, $\frac{\partial}{\partial t}(\psi^*\psi) = \psi^*\frac{\partial \psi}{\partial t} + \frac{\partial \psi^*}{\partial t}\psi$

Putting $\frac{\partial \psi}{\partial t}$ & its complex conjugate $\frac{\partial \psi^*}{\partial t}$ from (68) and simplifying we get

$$\frac{\partial}{\partial t}(\psi^*\psi) = \nabla\left[\frac{ikrv^2}{mc}\left(\psi^*\nabla\psi - \nabla\psi^*\psi\right)\right] \tag{70}$$

Thus, $\langle \mathbf{v} \rangle = \frac{\partial \langle \mathbf{x} \rangle}{\partial t} = \frac{ikrv^2}{mc}\int \mathbf{x}\nabla\left(\psi^*\nabla\psi - \nabla\psi^*\psi\right)d\mathbf{x}$ (71)

Doing integration by parts twice while assuming that ψ would go to zero at ±∞,

$$\langle \mathbf{v} \rangle = \int \psi^* \left(\frac{2krv^2}{imc} \nabla \right) . \psi \mathbf{dx} \tag{72}$$

Equations (69) & (72) can be generalized for insertion of operator between $\psi^* \,\&\, \psi$ while integrating. For any motion parameter (displacement, velocity, momentum, energy etc.), the expected average value of the parameter gets an expression that can be given the operator inserted $\psi^* \psi$ form. From (72) we get a scheme to calculate velocity. To get average value of velocity we have to put the bracketed operator between $\psi^* \,\&\, \psi$ and to integrate over the space. The operator is

$$\text{i.e. } \hat{\mathbf{v}} = \frac{2krv^2}{imc} \nabla \tag{73}$$

The mass being constant in the local frame, we also obtain the operator for momentum as

$$\hat{\mathbf{p}} = \frac{2krv^2}{ic} \nabla \tag{74}$$

Further we find the Hamiltonian as

$$\widehat{\mathbf{H}} = \frac{-2k^2r^2v^4}{mc^2} \nabla^2 + V \tag{75}$$

The general velocity operator (& also of momentum, Hamiltonian etc.) needs knowledge of the velocity, thus it is useless and so the general quantum mechanics. But if we substitute $\frac{\partial \psi}{\partial t}$ and $\frac{\partial \psi^*}{\partial t}$ from (54) instead of from (68), then we get the velocity operator which does not need knowledge of velocity itself. That mechanics with the special case along with that operator is established in last century which I am referring as the conventional or special quantum mechanics.

Through (73) we derived velocity operator (and all other operators are defined by using it). There we considered average of velocity be $\langle \mathbf{v} \rangle = \frac{\partial \langle \mathbf{x} \rangle}{\partial t}$ i.e. time rate of change of average of displacement. Thus this mechanics of ψ (i.e. QM) is based on assumption-average of a dynamic parameter is identified to be dynamics of the related average parameter.

D. The two approaches to study dynamics and the one feasible

There two approaches for study of the dynamics are possible. One is to derive dynamics for v=c case & apply it to the unknown but general velocities; and other is to derive dynamics for general velocities (68) and apply accordingly. First approach has advantage over the latter in a sense that it doesn't require knowledge of velocity of the particle under study. The operators with general dynamics like (73), (74) & (75) need knowledge of v. And exact velocity of the particles can't be known to the curious physicists. While the operators obtained by proceeding from (54) doesn't need knowledge of v. Further, it is nonsense to do analysis if we know the parameters priorly. Thus special dynamics with v=c case is preferable by experimenter or analyst. It is preferred simply because it is useful. The scheme of epistemic ψ is developed for inference by physicist, not for observation of system. And hence the special dynamic is advantageous over general one as long as the physicist is concerned with inference only and not the ontic/real observation.

It may seem to be inconsistent to apply the equations derived for special velocity c to other velocities. But it gains sense when we go for probabilistic expectation about many particles (or states) system and average of a dynamical parameter is identified to be so dynamics of the related/defining average parameter. The mathematical machinery of epistemic expectation ψ and operators is meaningless for the general approach i.e. what is dealt in section VIII-B-3 & VIII-C. It is useful & meaningful for the special approach (i.e. special dynamics) as with it, the dynamical parameters can be found without knowledge of themselves. Of course, application of the equations for special velocity to general cases will result in uncertainties in observations such as suggested in section VIII-B-2.

It is impossible to adopt the general approach for study of dynamics. Further, the experiments done in last century have agreed with predictions of the special approach. Thus hereafter we abandon the general dynamics of particles and concentrate on special dynamics with v=c case as it is feasible to be adopted. Crux of the special case is the fact that the expected energy of the particle/wave with velocity c is given by the Plank formula irrespective of its circumstances; while the mechanical energy of it is sum of all forms of energy associated such as E_k & E_P.

E. General equations for the dynamics on *M*

While deriving dynamics of epistemic wave, we considered local part of *M* where time is just local parameter of evolution, and energy content is sum of non relativistic kinetic energy & potential energy. But generally *M* has Riemannian geometry.

For this general derivation we will use same scheme. That is when expected energy and mechanical energy of the particle are multiplied by same space-time dependent function (field) ψ, then they should be equal i.e. (51). Thus we get space-time dependency of ψ. On general portion of *M*, energy of the particle is given by relativistic energy relation.

$$E^2 = p^2c^2 + m^2c^4 \tag{76}$$

On general portion of *M*, infinitesimal variations in general wave function i.e. derivatives of ψ are same as (49) & (50). Also noting that the approach to be adopted for study is the special approach, we will derive dynamical equation for velocity c for which expected energy in terms of frequency is given by Plank law & p=k'krc. Substituting for p in (76) we get

$$E^2 = (k'krc)^2c^2 + m^2c^4$$

Substituting for k' from general wave equation,

$$E^2\psi = -k^2r^2c^4\nabla_{\mathbf{x}}{}^2\psi + m^2c^4\psi \tag{77}$$

Now we have to use the indices like **x**, t & Greeks for identification of the derivative & tensor terms.

By Plank law we get

$$E^2\psi = k^2r^2c^2\omega^2\psi$$

Substituting for ω,

$$E^2\psi = -k^2r^2c^2\partial_t{}^2\psi \tag{78}$$

Equating (77) & (78) & rearranging we get the dynamics on larger portion of *M* which is known to be the Klein-Gordon equation.

$$\left(-\frac{1}{c^2}\partial_t{}^2 + \nabla_x{}^2\right)\psi = \frac{m^2}{k^2r^2}\psi \tag{79}$$

In Minkowskian metric η it can be written as

$$-\eta^{\mu\nu}\partial_\mu\partial_\nu\psi + \frac{m^2}{k^2r^2}\psi = 0 \tag{80}$$

This equation is based on energy relation (76) which is of second order. In order to get definite equality, all the terms should be of first order.

i.e. $E = c\sqrt{p_1{}^2 + p_2{}^2 + p_3{}^2 + m^2c^2}$

The numeric indices are to identify the local spatial components algebraically. The equality is held when it is multiplied on both sides by field ψ i.e.

$$E\psi = \left(\sqrt{p_1{}^2 + p_2{}^2 + p_3{}^2 + m^2c^2}\right)c\psi \tag{81}$$

By using Associative (precisely Clifford) algebra, RHS can be simplified as

$$\left(\sqrt{p_1{}^2 + p_2{}^2 + p_3{}^2 + m^2c^2}\right)c\psi = \alpha_1 p_1 c\psi + \alpha_2 p_2 c\psi + \alpha_3 p_3 c\psi + \alpha_4 mc^2\psi \tag{82}$$

For four terms, following subset of the Clifford algebra forms the smallest group [7], I being the identity matrix

$$G \equiv \left\{\pm.I, \pm\alpha_j\left(j \le 4\right), \pm\alpha_j\alpha_k\left(j < k\right), \pm\alpha_j\alpha_k\alpha_l\left(j < k < l\right), \pm\alpha_1\alpha_2\alpha_3\alpha_4\right\}$$

This group has order of 32 and 17 classes. And hence 17 irreducible representations of dimensions n_j such that

$$\sum_{j=1}^{17} n_j{}^2 = 32$$

But of these 17 representations, 16 are one dimensional and only one is four dimensional satisfying condition of Clifford algebra. Only the matrices of four dimensional irreducible representations satisfy conditions of Clifford algebra [8] which are familiar Dirac matrices.

$$\alpha_j = \begin{pmatrix} 0 & \sigma_j \\ \sigma_j & 0 \end{pmatrix} \text{ Where j=1, 2 \& 3 and } \alpha_4 = \begin{pmatrix} I_2 & 0 \\ 0 & I_2 \end{pmatrix} \tag{83}$$

Where σ_j are Pauli matrices and I_2 is 2 X 2 identity matrix.

Thus (81) becomes

$$E\psi = \alpha_1 p_1 c\psi + \alpha_2 p_2 c\psi + \alpha_3 p_3 c\psi + \alpha_4 mc^2\psi$$

Putting p_j= krck$_j$' and k_j' in terms of ψ (from general wave function) as $\frac{-i}{\psi}\partial_j\psi$

$$E\psi = -ikrc^2\alpha_j\partial_j\psi + \alpha_4 mc^2\psi \tag{84}$$

This is mechanical energy consideration. Total expected energy by Plank law turns out to of form

$$E\,\psi = \; ikrc\,\partial_t\psi \tag{85}$$

By equating both the energy expressions we get the Dirac equation.

$$-ikrc^2\alpha_j\partial_j\psi + \alpha_4 mc^2\psi = \; ikrc\,\partial_t\psi \tag{86}$$

It is for free particle. Note that the energy expression on RHS remains unchanged even if the system interacts with any external potential; this is because expected energy is always h*ν*.

Equation (86) can be expressed in terms of the gamma matrices as

$$ikrc\gamma^{\mu}\partial_{\mu}\psi - mc\psi = 0 \tag{87}$$

All the equations of dynamics viz. Schrödinger, Klein-Gordon & Dirac are derived explicitly with simple & obvious scheme. While deriving we didn't need to refer the operators. It is suggested that operator mechanism isn't fundamental. It is just another way to think the system (even the epistemic QM isn't fundamental, it is just useful for inference of real/ontic system). Momentum in particle's mechanical energy expression is substituted in terms of wave vector, and wave vector is substituted referring general wave expression. Hence we get differential operator that can be thought to replace the quantum momentum. Coincidently, the substitution from general wave equation and from statistical expectation (similar to (74)) we get same operator on ψ that can be considered to be counterpart of momentum. And hence we should be convinced to believe on statistical interpretation i.e. average of a dynamic variable is to be identified (or it is same) as dynamics of the corresponding average variable.

F. Collapse of wave function after measurement and the entanglement

The discussion is explicitly leading to well established physics phenomena. Entanglement is one of the blurry aspects of physics. The theory would provide explicit explanation of cause of entanglement.

An experimenter before the experiment expects every possible outcome to result with some probability. In other words, before the results of experiment being known, experimenter's expectation is linear combination of all states with coefficients of each state being the probability that outcome from experiment may result in that state. But as soon as experimenter gets results (i.e. by observation) he knows certain outcome of experiment i.e. only one state with unit probability. This reveals fact about collapse of wave function by measurement. This is possible because delta functions (those can be used to represent possible states) form basis of Hilbert space H [5] and the epistemic wave functions live in Hilbert space. Before observation, every outcome (i.e. state) has some probability to result; while after observation, only one outcome with unit probability. Such sudden change in knowledge of possible outcomes at instant of observation is obvious characteristic of an epistemic function.

Physics is possible because of the linkage of effects & corresponding causes. If any physical entities are related, then they preserve this relation as a physical constraint. Suppose certain properties of two (or more) particles are related in a system. Then it is demand of physics that they preserve that relation unless broken by physical cause. Hence if the property of one particle is understood or known then corresponding property which was related initially, of the related particle can be achieved by exploiting that initial relation. From experimenter's point of view, before observation the expectation of result is linear combination of all possible states with coefficients being probabilities; and due to lack of certainty in knowledge, nothing certain about other particles can be concluded. But as soon as observation of one particle is done, the related property of related particle can be achieved by using initially established relation between the particles. No matter, what result is obtained in observation, but other particle will always preserve the predefined relation. This phenomenon is widely known as entanglement. It is clear that one need not to be bothered about velocity at which information from one particle travels to other; because the relation between them exists as long as they exist in the system and hence determination at a particle determines that related at other particle. It is wrong to say that information from one particle travels to other but in fact those particles always preserve predefined relation. There is only matter that experimenter don't know- which snapshot he is taking by observing the system leading to blur in his knowledge. But he attains knowledge of system which is confined by predefined relation between particles.

Suppose, in an isolated system two coins are rotating with same angular velocities. At the starting, one was facing head towards a direction and other was facing tail towards same direction. As they are rotating at same speed, always preserve relative phase. When someone takes a huge snapshot of the system (or simultaneous snapshots of both the coins separately), then she will note that both coins always show opposite faces in the direction. In this experiment, it doesn't mean that information from a coin travelled to other in the moment of snapshot; in fact their dynamics is predefined- realized as entanglement.

Yet, there was no model/physics that can be considered underlying the epistemic dynamics. Hence the community was bound to refer the epistemic fields fundamental; and thus issue of entanglement and of the velocity of information between entangled systems was serious. As this theory provides a valid/feasible model about existence underlying the same epistemic universe, these issues aren't a concern at all. We regard the underlying or real universe be ontic universe and the yet accepted quantum universe be epistemic universe. Entanglement is a concern only when we have faith that-epistemic universe is fundamental and we don't doubt (apart from we don't know, we don't even see possibility) for a rational mechanism that would lead to the epistemic universe. But when we know the ontic model that should lead to the epistemic universe, entanglement is obvious and rational phenomenon.

IX. MATHEMATICAL FORMALISM

It is required to conclude rigid mathematical formalism for clear understanding and assessment of the theory. We started with most general 4-dimensional manifold; and as suggested by the evolution, come to conclusion that the space of universe is a 4-dimensional pseudo Riemannian manifold *M* which is locally Minkowskian. Thus consideration of some patch of *M* leads to realization of the patch (& *M*) in $\mathbb{R}^{1,3}$ (which is equivalent to $\mathbb{R}^4$). An observer attains particular realization of *M* as $\mathbb{R}^{1,3}$ through a coordinate chart $\xi : M \to \mathbb{R}^{1,3}$.

Embedding of spacetime points in the space of functions is possible in terms of the delta functions at every point. The set of delta functions at all points in *M* forms basis for the space dual to a Hilbert space of functions on the points. In other words, using the theorems by Kryukov- For an arbitrary 4-dimensional manifold *M*, there is an abstract Hilbert space **S** of continuous functions on $\mathbb{R}^4$ such that the set of all delta functions in the dual space **S*** is embedded submanifold of **S*** and is diffeomorphic to *M*. The map K: $M \to \mathbf{S}$, K(a) = δ^4_a is an embedding that identifies *M* with the submanifold of **S*** & thereby **S** of all delta functions. The set of delta functions is complete in **S** and all the delta functions are linearly independent (in the sense that they are independent functions and they can't be expressed in terms of each other). Hence the set of delta functions at all the points in *M* forms basis for the Hilbert space **S**.

An observer attains particular realization of *M* as $\mathbb{R}^{1,3}$ through a coordinate chart $\xi : M \to \mathbb{R}^{1,3}$. Due to the embedding, she simultaneously makes realization of **S** as $\Gamma : \mathbf{S} \to H$. A particular isomorphism Γ can be thought as coordinate chart on **S** [9]. Fig.3 helps to understand the formalism

$$
\begin{tikzcd}
\mathbf{S} \arrow[r, "\Gamma"] & H \arrow[r, "\delta_\Pi"] & H' \\
M \arrow[u, "K"] \arrow[r, "\xi"] & \mathbb{R}^{1,3} \arrow[u, "\kappa"] \arrow[r, "\Pi"] & \mathbb{R}^{1,3} \arrow[u, "\kappa"]
\end{tikzcd}
$$

FIG.3: The mathematical formalism showing mappings between different configurations

H, H' etc. are different realizations of same abstract Hilbert space **S**. Similarly $\mathbb{R}^{1,3}$s are different realizations of *M*. Πs are the transformations between such realizations and form the Poincare group. δ_Π maps delta functions to delta functions and preserves basis for Hilbert spaces. It preserves Hilbert & the indefinite (like (48) that completes the L_2 space) metrics. Arbitrary non-linear transformation acting continuously on *M* becomes linear when extended to **S**; and hence any group acting on *M* can be extended to **S** as pointed in [5]. The embedding preserves covariant properties of 4-tensors on *M*; usual 4-tensors are also elements of tensor algebra on **S**. Importantly, the embedding commutes with action of any groups of isomorphism on *M* including the Poincare group. This formalism is developed by Kryukov in rigorous mathematical way.

M is ontic universe i.e. it exists as fundamental by nature. Direct observation & study of this ontic universe at the CN or particle scale isn't possible by any curious. A better study is possible by considering epistemic universe **S** as the probabilistic sample space from which the information of ontic universe can be inferred. The Hilbert space **S** and its realizations *H*s concerned here are for single particles. By the equations of epistemic dynamics we can manifest probable outcomes (i.e. elements of *H*) as the quantum states of the particle. Linear combination of several states is also a state. The operators such as those discovered in section VIII-C have to be inserted in the expected state & its complex conjugate while integrating. As all the operators are linear, they have eigenvalues and corresponding eigenfunctions. These special-eigen characteristics (in $\mathbb{R}$ and *H*) are most probable out of all elements in $\mathbb{R}$ and *H* respectively for the operator.

Multiparticle states of n non-interacting identical particles can be specified by writing the state as a sum of tensor products of n one-particle states. This is because tensor product of Hilbert spaces is again a Hilbert space. If the number of particles is variable, then one can construct Fock space as the direct sum of the tensor product Hilbert spaces for each particle number. The well known creation and annihilation operators are derived in pure epistemic mathematical way. This all leads to the quantum field theory as all its ingredients are found (main principle of exclusion as established by Pauli isn't revealed here so far; as we aren't concluded bosons & fermions yet, we will get this in section XIV-B).

An epistemic wave function ψ can be exploited to infer properties of real system. The most general equation of dynamics of ψ is obtained by Clifford algebra of 4x4 matrices. Hence for epistemic study, *M* is needed to be given structure to have a 4-component ψ at every point i.e. fiber (spinor) bundle. In simple words, epistemic matter fields (specified by ψ) are sections of various fiber bundles over *M*, the fiber being complex vector or spinor spaces.

X. ELECTROMAGNETISM & ELECTRODYNAMICS

In last few sections we shifted our interest towards epistemic study. We found that the epistemic study is useful for a curious analyst. Though the real particles can't be observed, yet their real characteristics can be explored by modelling their real evolution. The theory with consolidation provides a real (ontic) model about particle existence underneath the well known epistemic functions/fields. We can proceed in the theory at the CN scale to explore the mechanisms and characteristics the particles (so the fields) can attain.

A. Electric charge

A particle gets its mass due to collision of the CN with another CN. Mass is the property related to CN's rotation due to the rectilinear version of a soul vector trapped tangentially. Consider the case when a massive particle (i.e. rotating CN) further collides with other one. In fig.4, plane of mass rotation of a particle & collision of it with other CN is shown. The collision is considered as external soul vector acting on the particle in tangent space. The bold oblique arrow is such external soul vector, while its components in the *mass rotation plane* & normal to the plane are also shown. The consolidation provides centripetal binding which makes tangential rectilinear vector to follow angular motion. Both the components of the external soul vector (with respect to the mass rotation plane) have different concerns. One component is coplanar with the mass rotation and other is transverse to it.

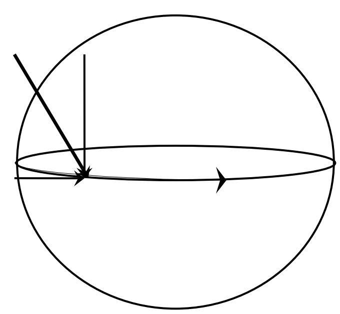

FIG.4:Soul vector acting on massive neighborhood gets split in components- a coplanar with mass rotation & a normal to it.

Consider the coplanar component. For the mass rotation, by (11) ω.s= c where, s is magnitude of the soul vector trapped tangentially inducing mass. If for instance, we consider the coplanar component of external soul vector due to second collision to arithmetically affect mass rotation, then there would be simultaneous increase or simultaneous decrease in both ω & s. Any case is impossible due to constancy of c. Thus simple addition of the coplanar component to mass inducing soul vector isn't allowed in order to be covariant & consistent theory. Instead, the coplanar component would get characteristically induced on the CN. In angular vector space (V_2 as in [4]) of the CN we get an angular vector acting on previous angular vector.

In the angular vector space we have two vectors. One is describing mass rotation of the CN (call it ***a***) and other acting on this ***a***, which comes from massive (second) collision and just converted in angular nature (call it ***b***). The angular vector ***a*** is element of angular vector space (V_2) existing due to the mass rotation. The ***b*** is induced from second collision and ***a*** induced from the first, both belonging to same Banach space. Due to the second collision, ***b*** acts on ***a***. In [4], vector product of two angular vectors is developed when one acts on other with angle θ as

$$\boldsymbol{a}\text{x}\boldsymbol{b}=\arccos\left[\frac{\cos a}{\cos\left\{\arcsin\left(\sin a.\ \cos\theta\right)\right\}}\right]b\boldsymbol{l} \qquad (88)$$

Where, ***l*** is unit angular vector in third angular dimension and *a* & *b* are magnitudes of angular vectors ***a*** & ***b*** respectively. In the case concerned, angle between ***a*** & ***b*** is zero, thus putting θ=0 and defining product to be ***q*** we get

$$\boldsymbol{q}=\boldsymbol{a}\text{x}\boldsymbol{b}=n\pi b\boldsymbol{l} \qquad \ldots\text{where n is an integer} \qquad (89)$$

(89) is making surprising statements, first of which is that this new angular vector quantity is quantized i.e. comes in integer multiples of *πb* if *b* is constant or quantized. Second is that due to independent vector nature of ***l***, it is either positive, negative or zero and undergoes addition with sign. Third is that ***q*** is independent of ***a*** which is function of mass i.e. ***q*** is independent of mass of the particle. Further, ***q*** is intrinsic property of particle i.e. it does not depend on surroundings and is associated with existence of particle that performed second collision. It is invariant under kinematic & relativistic circumstances i.e. dynamics of frames. These all are characteristics of electrical charge and hence we should concern that ***q*** is nothing but the electrical charge of the particle. Soon we will see that this charge creates interaction with other such particle, where the interaction is much stronger than gravity.

b is the angular soul vector induced due to second collision and ***q*** exclusively depends on ***b***. Every particle having ***b*** would have the ***q*** defined by ***b***, thus we can regard both these be aspects of same quantity i.e. angular soul vector induced from the second collision. This angular soul vector is an intrinsic property of the particle. Recognise that this angular soul vector (***b***) is different from the angular version of soul vector induced on CNs while the creation. To distinguish, we will call the one induced from second collision to be spatial angular soul vector (ASV), and the one induced while creation to be spacetime angular soul vector (SASV). Latter lives in general 4-dimensional CN while the former lives in spatial projection of the CN. The ASV has special existence due to the constraint ω.s= c of the mass rotation; due to the constraint it remains as characteristic angular soul vector induced on the particle.

B. Electromagnetic interaction

Fundamental assumption of this theory is that the soul vector in a system is conserved. Principle of conservation of a vector turns to its conservation in all the versions in which this vector comes; thus the angular soul vector ***b*** too should be separately conserved. (This angular vector is different from the angular vector induced on the CNs at the creation.) Soul vector trapped from second collision is angular in nature and it can't affect rectilinear soul vector (RSV) trapped from first collision (due to they form different Banach spaces). Rectilinear **s** and angular $\boldsymbol{s_a}$ magnitudes of soul vector are roughly related by radius r of the spheres of existence of $\boldsymbol{s_a}$ as [4]

$$\boldsymbol{s_a} = \mathbf{s}/\mathrm{r} \qquad (90)$$

We are using $\boldsymbol{s_a}$ as general notion for angular soul vector (i.e. ***b***) equivalent to magnitude **s** of RSV. Comparison of different types of soul vectors will be discussed in section XIV.

If direction of the ASV ***b*** is changing, then in order to conserve it, there should be generation of an ASV demand (analogous to the RSV demand that induces gravity). Such demanding package would get induced on adjacent CN and demand the unbalanced ASV wherever it reaches unsatisfied. Magnitude of such package is directed by (90). In order to accommodate ASVs at every point in epistemic model (i.e. to mimic the existence of ontic spatial CN), we are required to construct a fiber bundle where fiber is 2-dimensional vector space. This is because in the universe, spatial angular vectors live in 2-dimensional space [4]. Spin of the CN causes variation in direction of the ASV ***b*** associated with the particle, as will be discussed in next subsection.

Work done for causing change in a soul vector is given by (2). Same formula can be used where the Cause of ASV $\boldsymbol{s_a}$ variation causes angular displacement ***x*** i.e. placing $\boldsymbol{s_a}$ instead of **s** and ***x*** (i.e. angular displacement) instead of **x**. Continuous requirement of infinitesimal ASVs near the particle, would induce energy potential near it. Such potential energy gets reflected in Lagrangian or Hamiltonian near it. Corresponding instantaneous internal Lagrangian would be of form

$$\mathcal{L}_e = -k.f\ \frac{d\boldsymbol{s_a}}{dt} \tag{91}$$

Where, f is function of distance from the particle and $\mathcal{L}_e$ is instantaneous internal Lagrangian associated with the ASV interaction (i.e. the interaction induced due to spinning electrical charge). This interaction is nothing but the electromagnetic interaction. Note that ASV $\boldsymbol{s_a}$ in the Lagrangian $\mathcal{L}_e$.

Similarly, the gravitational internal Lagrangian due to RSV **s** is of form

$$\mathcal{L}_g = -k.f\ \frac{d\mathbf{s}}{dt} \tag{92}$$

Where, f is function of distance from the particle and $\mathcal{L}_g$ is instantaneous internal Lagrangian associated with the RSV interaction. This interaction is nothing but the gravity. Note that RSV **s** in the Lagrangian $\mathcal{L}_g$.

The instantaneous demands of RSV & ASV about a particle (hence the strengths of both the interactions) can be compared by comparing corresponding internal Lagrangians. Remembering (90) just make a glance on (28); you'll understand mystery of forces. The infinitesimals in rectilinear & angular vector spaces should obey (90). (90) provides a gross comparison of magnitudes of equivalent rectilinear and angular vectors on CNs. By (28), magnitude of kr is of order 10^{-43}; of which k ought to be of relatively larger order (we may decide it to be one by defining all units with respect to k=1) and r must be very small as it is radius of the CNs. Much smaller value of r is the cause of weakness of gravity relative to electromagnetism.

The RSV and ASV demanding packages propagate from the particle in a direction on M till getting satisfied. The ASV demand can be satisfied by only electrically charged particle as only it can have ASV. Further, as discussed in section V-D the package without driving energy can travel at speed c only. Thus a spinning electrical charge induces an opposite ASV demand propagating with zero consumption energy that propagates with c. This reveals that the ASV demanding package is nothing but the photon.

Let's calculate the instantaneous ASV demand on the CN.

On the spatial projection of the CN i.e. 3-ball, in angular basis of $\boldsymbol{m}$ & $\boldsymbol{n}$, let $\boldsymbol{b}$ is described as m$\boldsymbol{m}$+n$\boldsymbol{n}$.

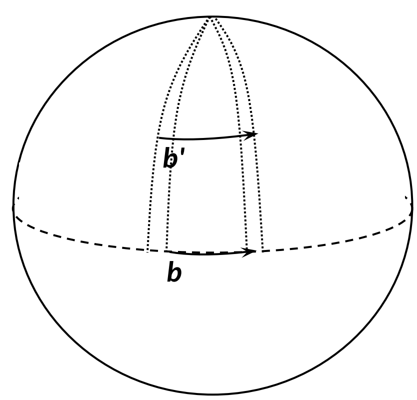

FIG.5:Projection of same angular magnitude at different position is different i.e. components change as ***b*** moves to ***b'***.

Identify ***m*** be unit angular vector along the equator and ***n*** be so along one of the longitude determining the angular frame. As shown in fig.5, as the position of ***b*** changes on the spatial 3-ball, its representation changes. Interaction caused due to variation in ***b*** i.e. electromagnetic force is direct function of d***b***/dt (what is the local rate of change of the ASV). Change in ***b*** is $\delta\boldsymbol{b}= (m_2-m_1)\boldsymbol{m}+(n_2-n_1)\boldsymbol{n}$ where, m_j & n_j are coordinate angular components. Let local angular frame be such that initial representation of **b** lies completely along ***m*** with ***n*** component being zero (as shown in the fig.5). Then as there is variation/spin transverse to ***b*** (due to the transverse component discussed in next subsection X-C), variation in ***b*** is completely configured by single parameter- velocity along ***n***- say Ω. Thus change in ***n*** component of ***b*** is $\delta(\Omega t)= \Omega\delta t$. Further, key thing is that magnitude of ***b*** is constant and change is due to direction only i.e. at two instants magnitude is same, thus according to [4]-

$$\cos m_1.\cos n_1= \cos m_2.\cos n_2$$

i.e. $\cos m_1.\cos n_1= \cos m_2.\cos[n_1+ \delta(\Omega t)]$

But due to our choice of frame, initial components are $m_1=b$ and $n_1=0$ which yields

$$\frac{\cos b}{\cos m_2} = \frac{\cos m_1}{\cos m_2} = \cos[\delta(\Omega t)] \tag{93}$$

Thus $\delta\boldsymbol{b}= \left(\arccos\left(\frac{\cos \mathrm{b}}{\cos \Omega \mathrm{t}} \right) - \mathrm{b} \right)\boldsymbol{m} + \Omega t\boldsymbol{n}$

$$\therefore \frac{d\boldsymbol{b}}{dt} = \lim_{h\to 0}\frac{1}{h}\left[\arccos\left(\frac{\cos \mathrm{b}}{\cos[\Omega(\mathrm{t}+\mathrm{h})]} \right) - \mathrm{b} - \arccos\left(\frac{\cos \mathrm{b}}{\cos \Omega \mathrm{t}} \right) + \mathrm{b} \right]\boldsymbol{m} + \lim_{h\to 0}\frac{\Omega(\mathrm{t}+\mathrm{h})-\Omega \mathrm{t}}{\mathrm{h}}\boldsymbol{n} \tag{94}$$

Second term in above limit vanishes as Ω is constant. The angular vector given by (94) is instantaneous ASV demanding package in a frame of the CN. This demand package is generated due to spinning of ***b*** (i.e. of electrical charge). Such package is certainly associated with (spinning) electric charge. The ASV demanding package does role of virtual photon. It travels with speed c only. Thus we consider this package as photon mediating electromagnetic interactions. Note that a charged particle (i.e. a CN that undergone two collisions) can absorb or emit this photon. The photon in form ASV demanding package can go from one space & time location to another. From these two assumptions along with an obvious for charged particle movement, Feynman explained skeleton of QED in [10]. The gauge covariant derivative for epistemic study (QED) will be explored & the gauge action in epistemic sense is discussed in section XII.

It is prediction of this theory that the electrically charged spinless fundamental particle can not undergo electromagnetic interaction as there would be no variation in the associated ASV.

C. Spin

So far in this section we considered the coplanar component of external soul vector from second collision with respect to the mass rotation plane. Now, we would concern the normal component. This component acting tangentially to the CN, due to provision of centripetal binding causes the rotation. This is rotation of mass and hence gives rise to angular momentum. This component of the external soul vector causes rotation or spin of the massive particle; while the other (coplanar) can't cause so due to the $\omega.s= c$ geometry and remains as induced ASV. Such mechanical rotation of mass should leave trace in calculations of mechanics that we detect by conventional principle- due to conservation of angular momentum. This transverse component should be nothing but the spin we know.

Really, spin is necessary for action of forces. It rotates the mass rotation plane and also causes rotation of the associated ASV which subsequently causes electromagnetic interaction. Thus it is major consequence of this theory that a charged fundamental particle with absence of spin (or zero spin) can not undergo electromagnetic interaction, however a charged composite particle with zero net spin can interact electromagnetically. Our discussion in section VI says that mass demands RSVs in plane of mass circle only suggesting that the gravitational force would act in this plane only. Spin makes normal rotation of that mass rotation plane resulting in RSV demand in all the spatial dimensions, thereby making gravity an isotropic force in spatial dimensions on larger scale.

Angular momentum of 2-sphere (3-ball) of radius r & angular velocity Ω is given by $\frac{2mr^2}{5}.\Omega$, as ω & Ω both are angular velocities they have same units and are proportional (as are constant for the CN or particle). Thus angular momentum is directly proportional to $\frac{2mr^2}{5}\omega = \frac{2mr^2}{5}\frac{\mu c}{r} = \frac{2\mu^2 krc}{5}$. We know that $\mu = \frac{r}{s}$ i.e. it would be dimensionless on the fundamental scale. Also (27) reveals that krc=ħ. In other words, on the geometric i.e. fundamental scale where we know that mass is a form of energy & not quantity of matter, intrinsic angular momentum (due to spin) can be expressed in units of ħ. This result of the theory agrees with the established physics, and sustains claim about validity of it.

"It is concluded that spin is essentially wave (i.e. associated with existence of the entity) property and not Quantum Mechanical (the tool by which we observe it). It isn't internal" [11]; this conclusion is straightforward from the proposed interpretation of spin.

D. Intrinsic magnetic moment

An electrically charged particle with spin is similar to a current loop as spin is nothing but the rotational motion of electrical charge i.e. current. We know that a closed current loop results the magnetic dipole moment normal to plane of loop. Therefore an electrically charged particle with spin must have intrinsic magnetic dipole moment. Further, it is worth to note that such any particle in universe can have magnetic dipole only and not the monopole. This is because a spinning particle always has two sides associated with spin i.e. two sides of plane of the spin. One can configure these both directions by suitable reference say right hand rule. This is demand of the formalism as both the sides of spin plane are not indistinguishable since those are characterized by a vector (i.e. spinning direction). Considering fingers of right hand curled along spinning direction if one defines direction given by its thumb as North Pole & its opposite as South Pole, then those poles never can be separated by any possible mean. Thus either magnetism exists via dipole or it doesn't exist, but there can't be magnetic monopole.

Considering formula for magnetic moment of current loop & applying its differential formula for spatial projection of the CN of radius r and finally integrating over the particle, I got magnetic dipole moment of particle to be $\frac{\mathrm{n}\Omega b\pi^2\mathrm{r}^2}{2}$ where, Ω is angular velocity due to spin and $\mathrm{n}\pi b$ is electrical charge of the particle. But this formula may not be applicable at the CN scale as it is based on classical macroscopic observation/derivation of current loop. But by a conclusion that certain vector magnetic moment is associated with spinning particle, we can obtain Pauli equation.

In the epistemic equations of dynamics, mechanical energy expression of the spinning charged particle should concern the potential energy due to interaction of the magnetic dipole with magnetic field around the particle in *M*. While deriving the (Pauli) equation, one has to substitute dot product of the intrinsic magnetic moment with external magnetic field; thus the direction of magnetic dipole is needed to be configured. This needs another fiber to be considered to accommodate the spin (or magnetic moment). Spin is rotation in the 3-dimensional spatial space. As elaborated in [4], the pseudovectors are actually angular vectors. Hence spin is angular vector. Rectilinearly 3-dimensional space is angularly 2-dimensional. Thus we are needed to consider the spin fiber to be a 2-dimensional vector space. The general number field of epistemic universe is complex, hence transformations between spin would be specified by the complex rotations. As the spin fiber is 2-dimensional, its group of transformations can be SU(2).

E. The particles following same dynamics

The properties of the charged particle those reflected in equations governing its

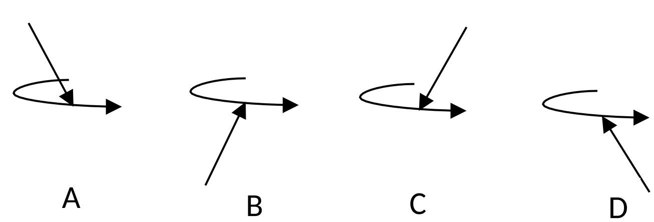

FIG.6: Possibilities of the second collision with same angle showing four different conditions

dynamics are mass, electrical charge & spin. The second collision makes the picture clear. For same acute angle of collision (external soul vector), there are four possibilities as shown in fig.6. There the rotation of mass circle (induced from first collision) and the external soul vector due to second collision (as arrow) are shown. Thus collisions as in both the fig. 6A & fig. 6B induce angular vector ***b*** in same direction of mass rotation, but mutually opposite spins. Collisions as in both the fig. 6C &fig. 6D induce ***b*** in opposite direction to the mass rotation, but their spinning directions are opposite. For same magnitude of the external soul vector, all the four particles will have same magnitudes of electrical charge, mass and spin; but having different combinations of the directions. Same spin results in same dynamics of interactions, same mass means same gravitational & relativistic effects and same magnitude of electrical charge results in similar electromagnetic interactions.

Therefore a specific epistemic function ψ would result in expectation of all these 4 particles (as the 4 verities follow same mechanics). Coincidently, the relativistic equation derived with aid of Clifford algebra results in 4 component solution. The four components of ψ can be identified with these four different particles having same intrinsic properties following same dynamics. Though following same dynamics, they may have different expectation values is specific cases. These four versions (can be considered of a particle) also show chirality as the fact that distinguishes within them. Again, this is good match between the epistemic & ontic physics, through the Dirac algebra and the mass-spin-charge combination respectively.

While deriving Klein-Gordon equation, we equated expressions $E^2\psi$ in mechanical & expected considerations. But by arguing for exact equality, we equated $E\psi$ expressions to get Dirac equation. Argument for Dirac equation is that when we equate $E^2\psi$, on either sides of the '=' it doesn't need E^2 always, there can be E^2 on a side & $(-E)^2$ on other. That is, there can be particles with negative energy whose squared energy is same as that of particles having positive energy. How to interpret the particles with negative energy? Conventionally there are interpretations from Dirac & Feynman, but our explicit theory needs explicit interpretation. Essential characteristic of negative energy is that when it gets added to positive energy, net energy is zero. Energy of a particle is due to mass only (as the charge is conserved separately & energy consumed in spin gets reflected in angular momentum). In order to get zero energy, the mass has to be cancelled i.e. the first rotation should be stopped. We will get zero energy only if two particles with (equal but) opposite charges & spin and with same mass come in contact (i.e. both get in tangent spaces & to be neighbours of each other in *M*). Each half rotation (due to spin) changes the direction of mass rotation on *M*. Then there is chance that mass rotations (and also the spinning) can be stopped yielding just the CNs with no rotations i.e. zero matter. Conclusively, two particles with same mass but opposite spin & electrical charge, can annihilate each other and can be considered as antiparticles of each other. Then negative energy has only relative meaning i.e. for particle with energy E, there is meaningful one with energy –E; but a particle with negative energy different than –E has no meaning. Thus if there is imbalance between both the types, then remaining must be the positive energy. Simply, negative energy has meaning for annihilation of a counterparticle only and not in general. This explains excess of matter over so called antimatter.

Major implication from the theory to note is that only massive particles can have antiparticles. This is because electrical charge & spin can't exist without mass. If one pretends a CN to undergo directly second collision, then it will get induced mass by tangential trapping of the RSV. For induction of ASV, RSV needs to exist priorly offering the defining geometry.

Also the particles which do not have antiparticles will follow the Klein-Gordon equation, but those having antiparticles will not and their dynamics is governed by the Dirac equation. Thus the four versions of an epistemic particle as in fig.6 would exist if the antiparticles are possible. If the antiparticle of a particle doesn't exist, then it wouldn't have the four versions; thus it shouldn't have electrical charge.

XI. DARK THINGS

Existence of Dark Matter (DM) is well confirmed [12,13]. Various particles are epistemically proposed to be candidates of DM [14, 15, 16 etc.]. "Dark Matter cannot be any particle of the standard model since all stable standard model particles except the neutrino and the graviton, either emit photons or would have left their imprint on nucleosynthesis." [17] We are going to find that DM & Dark Energy are different from ordinary matter ontically by nature.

A. Dark Matter

The DM does not absorb, emit, or scatter light of any wavelength, and has only been seen by its gravitational influence [18]. Our discussion in section X-B says that photon is nothing but the ASV demanding package. Thus a particle can absorb or emit or scatter photon only when it has such ASV. In other words, second collision is necessary in order to absorb or emit or scatter photon. If a particle not performed second collision, then it can't affect the demand of ASV demanding package coming to it, as only massive particle having no electrical charge does not have any ASV change generated (or even the ASV). Unaffected motion of ASV demanding package is same as non scattered motion of photon. Conclusively we say that a CN that followed only one collision inducing mass and not other that induces electromagnetism can't absorb, emit or scatter photon. And such matter can be detected by gravitational observations only, to which we call as the Dark Matter. As this matter has mass and corresponding rotation, it demands RSV packages instantaneously and also satisfies the RSV demanding packages falling on it; and thus it attracts all the things having RSV i.e. it follows Gravitation. Due to absence of spin, DM particle demands soul vector in the mass rotation plane only. Many differently oriented & clustered such particles can result in familiar gravitation. Such clusters can get formed at far from beginning of the universe, thus it is prediction of the theory that considerable effect of dark matter would made influence in later stage of the universe. These particles show gravity only and not other interactions thus they don't leave trace in the nucleosynthesis.

B. Dark Energy

It is possible that a CN not followed any collision at all. An interesting thing happens with such CN. When it receives successive RSV demanding packages from a massive particle, its soul vector points to and it gets attracted toward the massive particle. This is pure gravitational attraction but difference is that it isn't mutual attraction. When such CN comes in contact with the massive particle due to the RSV dynamics, its soul vector (RSV) gets transferred to the particle (like $\mathbf{s}_r$ in section IV-A). As such soul vector is transferred; the massive particle undergoes acceleration away from the CN (as a result of collision). There is no mutual attraction to affect or dilute this repulsion. Due to inertness of the CN, soul vectors of both are collinear and thus much of that of the CN is transferred to the massive particle. Once such transfer is done, the CN is at (almost) rest & starts to receive further RSV demanding packages till it gets in contact with the particle once again to transfer its acquired RSV. In this way a CN can result to repulsive acceleration of mass. Two such CNs are sufficient to change gravitational attraction between two particles into repulsion if they come in geodesic path between those particles and there is no other dominant Cause to remove them from the path. This is well observed phenomenon of what we know as Dark Energy (DE).

If our model of DE is true, then its important characteristic is that acceleration due to it isn't continuously uniform but discretely i.e. at successive time intervals velocity increments are received.

We will revisit this mechanism in section XV after development of key concepts.

C. Remarks

What is possibility of creation of mass and electrical charge? After the Creation or Big Bang, the universe M is composed of two types of constituents- CNs and unconsolidated points. The CNs move through M due to RSV. For creation of mass, one collision between CNs is required while two such collisions are required for that of electrical charge (& spin). As we strongly believe that there was almost nothing before Big Bang, the space *M* ought to be almost isotropic. In such space there is very low possibility that collision happens. Possibility of additional collisions is much lower. Today we don't have statistical constraints to convert these possibilities into probabilities. But general sense is convincing with observation that in the universe, uncollided CNs are 73%, those collided once are 23% and those collided twice are just 4%. This explains matter in the universe nicely that concluded from the WMAP experiment [19].

XII. FUNDAMENTAL INTERACTIONS AS EPISTEMIC GAUGE THEORIES

Different versions of soul vectors (viz. rectilinear, angular & sangular) are associated with the CNs intrinsically, and their variation leads to a corresponding type of interaction. So far we considered the rectilinear typed soul vector induced while the creation on the CNs. But additionally there are similarly induced angular & sangular soul vectors (as discussed in section II & in [4]), change in them (due to the rotations induced by collision) would generate the corresponding typed soul vector demanding packages. Thus there would be additional typed interactions between the particles in *M*, apart from the gravity & electromagnetism.

M is infinitesimally piecewise rectilinear and thus rectilinear vectors- hence the RSVs live in tangent spaces on *M*. This isn't the case with the angular and sangular soul vectors; they live only on the CNs. At the beginning, rectilinear, angular & sangular soul vectors were induced on CNs. The angular soul vector induced was in general 4-dimensional space. As stated already, let's call the angular soul vector induced at the beginning of universe be Spacetime Angular Soul Vector (SASV). The ASV which induces the characteristic of electromagnetism arises due to collisions of CNs in *M* where locally time is a parameter of evolution and hence it doesn't contain time dimension in constituents of ASVs, i.e. this electromagnetic ASV is Spatial Angular Soul Vector (in short form we are writing it as just ASV). Both types of angular soul vectors viz. ASV & SASV have isolated existence and they don't affect arithmetic of each other (in other words, they live in different Banach spaces). This is due to the SASVs cause simple rotations of the CNs in general 4-dimensional superspace, while the ASVs not (they are just trapped on the CNs) because the product ω.s must be c. (the RSV causing mass rotation is conserved separately by gravity; it lives in different Banach space) *M* & CNs are rectilinearly 4-dimensional and an angular dimension is composed of two rectilinear dimensions. It is clear that rectilinearly 4-dimensional space is equivalent to angularly 3-dimensional space. If any soul vector to be configured in the universe by fiber bundle, then the fibers must span the CNs or their corresponding projection. Hence epistemically, the fiber to accommodate SASVs should be a 3-dimensional vector space. The ASVs live in rectilinearly 3-

dimensional (spatial) equivalent to angularly 2-dimensional space and hence fibers accommodating ASVs should be 2-dimensional vector space. Further, a sangular dimension is composed of three rectilinear dimensions, thus rectilinearly 4-dimensional space is equivalent to sangularly 2-dimensional space. Therefore the fiber accommodating sangular soul vectors should be 2-dimensional vector space. Finally note that all the required fibers (in epistemic universe) are 4-balls i.e. the physical CNs (in ontic universe). Angularly 3-dimensional and sangularly 2-dimensional spaces are equivalent to 4-balls; the angularly 2-dimensional space is equivalent to 3-ball i.e. spatial (local) projection of the 4-ball. Thus CNs in ontic universe M are fibers in epistemic universe **S**.

No portion of M except the CNs can accommodate angular & sangular vectors (meaning that any points on M never be specified by such vectors in any frame) because M isn't piecewise so. But M being infinitesimally piecewise rectilinear, RSVs live in the tangent spaces & thereby on M generally. Thus no special fiber structure is needed to accommodate RSVs; they are sections of trivial fibers i.e. tangent spaces. The ASVs, SASVs & sangular soul vectors (SSVs) can be represented as sections of the appropriate fibers (configuring the CNs) on M. Fibers for SASVs, SSVs & ASVs are three, two, & two dimensional vector spaces respectively. As M can't accommodate them, these soul vectors will travel on M in passive manner via getting transferred on neighboring fibers (ontically, on neighboring CNs) as corresponding sections (vectors). While RSVs travel on M in active manner i.e. via tangent spaces, therefore collisions & the dynamics happen due to RSVs only. Conservation of soul vector implies conservation in all the versions i.e. of RSVs, ASVs, SASVs & SSVs. Direct product of the fibers can be constructed for unified epistemic approach. But here we will discover the characteristics related to conservation of all the types of soul vectors separately.

For dynamics of all the soul vectors, core scheme is same. We should equate expressions of mechanical energy & expected energy of the particle multiplied on both sides by the epistemic function field. When a particle exists in a pool of soul vector demanding packages, its mechanical energy gets affected in two ways- the corresponding external potential felt by the particle and momentum affected of the particle. We have to substitute these resultant considerations (momentum & potential) in the mechanical energy of the particle while deriving local equation of dynamics.

Capability of interaction i.e. that to affect own momentum & to feel external potential is directly related to the concerned soul vector associated intrinsically with the particle. The particle has each version of intrinsic soul vector; when a soul vector demanding package falls on it, then the interaction strength is direct measure of quantity of the soul demand satisfied by the particle. The satisfaction of the demand of soul vector by the package falling on a particle would be directly proportional to the change in corresponding intrinsic soul vector the particle has. And change in the intrinsic soul vector is directly proportional to magnitude of it as the change is in direction only (at constant rotation rate). Variation in soul vector of a particle is due to change in direction only and its magnitude is constant; thus under same circumstances, variation in larger soul vector will induce higher soul vector demand. Or conversely, variation in larger soul vector will satisfy higher demand of the soul demanding packages falling on it. Hence, higher the associated intrinsic soul vector- higher is the interaction. Interaction leads to variation in momentum, thus higher interaction leads to higher variations in momentum of the particle. Also, a particle with higher soul vector will feel higher external potential in pool of same typed soul vector demanding packages. Conclusively, the incremental momentum & marginal external potential due to an interaction are directly proportional to the corresponding typed soul vector intrinsically associated with the particle.

It is worth to note that the intrinsic soul vector associated with the CN and same typed soul vector demands live in same vector spaces. This is due to the soul vector demands are just the unbalanced soul vector.

A. The SSV interaction or Weak interaction

First consider the SSVs. SSVs live on the CNs which are sangularly 2-dimensional. Thus an SSV can be represented as linear combination of two basis SSVs on a CN. The ψ is already a four component entity as discussed in section X-E having same magnitude of intrinsic properties but having their different vector combinations. This is because particles with same magnitudes of mass & electrical charge would follow same local dynamics. In fact like mass & electrical charge, associated SSV too is intrinsic property of the particle causing interaction. Further from this, the particles with same magnitudes of intrinsic SSVs say ζ_w (however having different representations in the 2-dimensional fiber) should follow same local dynamics. Therefore the epistemic ψ should have eight components. But the Clifford algebra on M results in four component only for ψ. Therefore, a way for mathematically consistent formalism is to consider the ψ having two spinor components. The differentiation between both the components should be done as having difference in intrinsic SSV and having remaining intrinsic properties same. In other words, the ψ is needed to be considered as SSV doublet in epistemic universe **S**. These doublets i.e. matter fields of SSV interaction can be represented as sections of the 2-dimensional vector bundle over M.

In the epistemic universe, for configuration of the SSV interaction we have a 2-dimensional complex vector bundle. According to the Wigner's theorem, any continuous symmetry transformation in the epistemic universe is represented as unitary transformation. Therefore the transition functions for the vector bundle belong to U(2) group. Hence the structure group of the vector bundle is U(2). But U(2)= SU(2) X $\mathbb{R}$ i.e. any element of U(2) can be represented as an element of SU(2) times an appropriate number corresponding to U(1). Thus the vector bundle determines unique principal bundle from which the original bundle can be reconstructed. For such principal bundle, there would be natural SU(2) action on the total space that acts transitively on the fibers. There is the principal bundle with fibers being SU(2) group having associated the 2-dimensional complex vector bundle of SSV doublets. The group SU(2) generates its Lie algebra su(2) and representations of su(2) can be used to generate representations of SU(2) i.e. SSVs.

Now consider a particle having intrinsic SSV ζ_w dipped in lots of SSV demanding packages falling on it (can be considered as external SSV field). The external potential felt due to the surrounding SSV demanding packages by the particle is

$$V_w' = - \zeta_w V_w \tag{95}$$

Where, V_w is absolute potential on unit SSV due to same SSV demanding packages (field). V_w is absolute (applied) potential and V_w' is potential satisfied due to SSV ζ_w. RHS of (95) is the SSV demand satisfied which would reduce the potential and hence there is minus sign. (Note that (95) doesn't mean repeated sum) If V is the general potential due to all types of interactions & kinetics, then due to SSV demand satisfaction (95), net potential V' will become reduced by the amount (95)

$$\text{i.e. } V'=V-\zeta_w V_w \tag{96}$$

Now, let's concern the effect on momentum. Due to the external SSV demanding packages, the particle gets accelerated and its momentum changes. The change in momentum again depends on capacity of the particle to satisfy the SSV demands and hence is directly related to ζ_w. It is fair thought that locally there is the potential A_j in each spatial direction which increases momentum in j direction by $\zeta_w A_j$. Thus the (general) canonical momentum (p_j being original kinetic or free momentum) of the particle on tangent bundle of *M* is

$$p_j'= p_j+ \zeta_w A_j \tag{97}$$

These refined potential & momenta have to be used while deriving most local equation of epistemic dynamics. Our scheme for this is clear- equate $E\psi$ in terms of mechanical & expected expressions.

$$E\psi = (\text{KE+PE})\,\psi = \left(\frac{\sum p_j^{\,2}}{2m} + V\right)\psi .$$

Due to the SSV interaction, potential V & momenta p_j have incremental changes so that their net values are as given in (96) & (97); we have to substitute p_j' instead of p_j and V' instead of V while accounting the SSV interaction. Further, p_j=k_j'krc and from general wave equation $\psi = A.e^{i(k_j{}'x_j - \omega t)}$, $\partial_j\psi = ik_j{}'\psi$, then using such expression for k_j' while substituting, we get

$$E\psi = \frac{-k^2r^2c^2}{2m}\sum_j\left[\partial_j - \left(\frac{i\zeta_w A_j}{krc}\right)\right]^2\psi + \left(V - \zeta_w V_w\right)\psi$$

Next, from the general wave equation, $\partial_t\psi = -i\omega\psi$ and from Plank law, E=$\hbar\omega$, Using these both we get expected energy of the particle-

$$E\psi = irkc\partial_t\psi$$

Now, equating both the $E\psi$ expressions and rearranging we get

$$\frac{-k^2r^2c^2}{2m}\sum_j\left[\partial_j - \left(\frac{i\zeta_w}{krc}\right)A_j\right]^2\psi + V\psi = irkc\left[\partial_t - \left(\frac{i\zeta_w}{krc}\right)V_w\right]\psi \tag{98}$$

This can be given the form

$$-\left(\frac{k^2r^2c^2}{2m}\right)\boldsymbol{D_j D_j}\psi + V\psi = ikrc\boldsymbol{D_0}\psi \tag{99}$$

By defining $\boldsymbol{D}_\upsilon = \partial_\upsilon - \left(\frac{i\zeta_w}{krc}\right)A_\upsilon$ (100)

Where, V_w is identified as A_0 (index 0 being time), and A_υ are referred as components of same one-form (sangular potential).

Through above procedure we formulated all rates of change (dynamics) in terms of the covariant derivative with respect to a connection (100). A covariant derivative is a linear differential operator which takes the directional derivative of a section of a fiber bundle in a covariant manner. Here the bundle is

SSV vector bundle accommodating the SSV doublet ψ. The covariant derivative would act on this doublet.

(100) defines a linear connection C_w on the bundle of SSVs as

$$C_{w\upsilon} = -\left(\frac{i\zeta_w}{krc}\right)A_\upsilon \tag{101}$$

In (99), we see no concern about the SSV bundle. (99) is same as (54), it means- the dynamics is unchanged if the gauge covariant derivatives are used instead of usual derivatives and the dynamics supposed to be invariant under change of the connection (101), (i.e. the intrinsic SSV ζ_w magnitudes are considered causing interaction with gauge (external SSV) fields A_υ). This is nothing but the gauge principle of QFT. In different patches on *M*, there are different choices for A_υ. But the general equations of dynamics (54, 99) and Lagrangian & Hamiltonian should be invariant with these choices if covariant derivative is used instead of usual derivative. However for two overlapping patches, A_υ have to agree by the transition functions.

We are exploring for epistemic dynamics, hence we can do mathematical tricks without bothering for ontic correspondence. To make it simple, we can separate magnitude of the intrinsic SSV to treat to be scalar and make product of its unit representation with the potential one-form. We are going to do this just for the agreement with standard model. Thus we can regard A_v as su(2) valued one-form and ζ_w as scalar. Then A_v have representation as $\sigma_j W_v^j$ where σ_j are generators of su(2) and W_v^j are matrix coefficients. W_v^j can be referred as the new fields in terms of the σ_js determining the potentials A_v. Now, the connection takes new form as

$$C_{wv} = -\left(\frac{i\zeta_w}{krc}\right)\sigma_j W_v^j \tag{102}$$

Using this connection, the gauge covariant derivative is

$$\boldsymbol{D}_\upsilon = \partial_\upsilon - \left(\frac{i\zeta_w}{krc}\right)\sigma_j W_v^j \tag{103}$$

This is exact gauge covariant derivative for the weak interaction if ζ_w referred as the coupling constant. Thus it is clear that the interaction caused by conservation of SSV is weak interaction we know. For two overlapping patches, SU(2) is the group of transition functions for choice of A_υ.

Basically the intrinsic SSV is su(2) valued, but we regarded here its magnitude ζ_w as scalar and used its representation for gauge potentials. This is just a mathematical trick to separate the scalar multiple from the unit representation. Thus either SSVs or the potentials can be regarded as gauge fields by treating magnitude of other of them scalar. In standard model, SSV magnitude is regarded as constant and the potentials are gauge fields. Ontically, the weak potentials A_v are quantifications of the SSV demanding packages while ζ_w are intrinsic SSV associated with the particle. They both live in same vector space and hence as elaborated before, we regards the quantification of SSV demanding packages be su(2) valued one-form and the intrinsic SSV be scalar.

B. The SASV interaction or Strong interaction

Consider the intrinsic SASV associated with the particle varying with time. Then it generates SASV demanding packages around or generates a SASV field. Or conversely, if such particle is surrounded by SASV demanding packages, then it satisfies some of their demands. Any particle with varying intrinsic soul vector generates a field around it and interacts with the same typed external field. In very similar fashion to the one in last section for SSV interaction, characteristics of SASV interaction can be discovered. Major difference with SASVs is that they live in 3-dimensional space. As a particle i.e. CN is 4-ball, it has geometry to accommodate three linearly independent SASVs. Thus epistemically, an arbitrary SASV is linear combination of the three basis SASVs. Particles with same intrinsic properties and same magnitude of SASV will follow same dynamics. Same magnitude SASV can have different contributions of the three basis SASVs i.e. epistemically an SASV should be considered as mixture of the three SASVs. In other words, a particle with same mass & electrical charge can have three different SASV representations following same dynamics. Thus a particle is needed to be SASV triplet in **S**. We are needed to construct a three dimensional complex vector bundle over *M* to accommodate the triplet in **S**.

Now, according to the Wigner's theorem, any continuous symmetry transformation in epistemic space **S** is unitary. Hence the group of symmetry for SASV bundle is U(3). Again, any element of U(3) can be represented as element of SU(3) times a number, due to U(3)= SU(3) X $\mathbb{R}$. Thus the SASV vector bundle determines unique principal bundle from which the original bundle can be reconstructed. For such principal bundle, there is natural SU(3) action on the total space that acts transitively on the fibers. The group SU(3) generates its Lie algebra su(3) and representations of su(3) can be used to generate representations of SU(3). There is the principal bundle with fibers being SU(3) group having associated the 3-dimensional complex vector bundle of SASV triplets.

An interaction of a particle locally on *M* results in variation of its momentum in spatial directions and variation in the net external potential it feels. Let $\boldsymbol{\zeta_s}$ be the intrinsic SASV associated with the particle. Then as discussed in section XII-A, we can consider A_j be the potential which affects momentum of the particle in j direction. Thus the net momentum of the particle is

$$p_j' = p_j + \boldsymbol{\zeta_s} A_j \tag{104}$$

Also, the net potential it would feel due to SASV applied potential V_s is

$$V' = V - \boldsymbol{\zeta_s} V_s \tag{105}$$

Using (104) & (105) for deriving dynamics with our scheme we get equation of most local dynamics on *M* as

$$\frac{-k^2r^2c^2}{2m}\sum_j\left[\partial_j - \left(\frac{i\zeta_s}{krc}\right)A_j\right]^2\psi + V\psi = irkc\left[\partial_t - \left(\frac{i\zeta_s}{krc}\right)V_s\right]\psi \tag{106}$$

This can be given the form

$$-\left(\frac{k^2r^2c^2}{2m}\right)\boldsymbol{D_j}\boldsymbol{D_j}\psi + V\psi = ikrc\boldsymbol{D_0}\psi \tag{107}$$

By defining $\boldsymbol{D}_\upsilon = \partial_\upsilon - \left(\frac{i\zeta_s}{krc}\right)A_\upsilon$ (108)

Where, V_s is identified as A_0, and A_υ are referred as components of same one-form (spacetime angular potential).

It defines a linear connection C_s on the bundle of SASVs as

$$C_{s\upsilon} = -\left(\frac{i\zeta_s}{krc}\right)A_\upsilon \tag{109}$$

It is evident from covariant equation that the gauge principle is a characteristic of SASV interaction too. Potentials A_v are spacetime dependent (according to a patch) and then corresponding covariant derivative yields invariant results.

Similar to the SSV case, we should regard A_v as su(3) valued one-forms and ζ_s as scalar. Then A_v have representation as $\lambda_j S_v^j$ where λ_j are generators of su(3) and S_v^j are matrix coefficients. Now, the connection takes the form

$$C_{sv} = -\left(\frac{i\zeta_s}{krc}\right)\lambda_j S_v^j \tag{110}$$

Using this connection, the gauge covariant derivative is

$$\boldsymbol{D}_\upsilon = \partial_\upsilon - \left(\frac{i\zeta_s}{krc}\right)\lambda_j S_v^j \tag{111}$$

(111) is exact gauge covariant derivative for quantum chromodynamics (strong interaction) if ζ_s referred as coupling constant. Thus it is revealed that the interaction caused by conservation of SASV is strong interaction of chromodynamics and the intrinsic SASVs are nothing but the color charges. The generators for representation of potential due to SASV demanding packages are gluons. As the potential is quantification of SASV demanding packages, gluons ontically mean such packages.

C. ASV interaction or electromagnetic interaction

Cause of the electromagnetic interaction is ASV ***b*** which is spatial angular soul vector. The spatial angular vectors do not have time dimension in angular directions; hence they live in rectilinearly 3-dimensional space which is equivalent to angularly 2-dimensional. Other intrinsic properties being same, a particle can have mixture of 2 linearly independent ASVs. This seems as the particle should be considered as ASV doublet. But the electrical charge is already contributing to the 4-component ψ (or 4-spinor). To be absolute (or elementary), a particle with same magnitudes of mass & spin should be considered as ASV doublet. Basically, a particle with the mass & spin is epistemic doublet (or 2-spinor) as it can have two possible combinations of mass & spin directions with same magnitudes. Thus if a particle is to be considered as ASV (or electrical charge) doublet, then the doublet is of 2-spinor (unlike the multiplets of 4-spinor in cases of SASV & SSV). Hence the doublet is actually 4-component entity, in total the differentiation being made with respect to ASV. But this entity is equivalent to the 4-spinor. For consistent formalism, the particle should be considered as 4-component singlet instead of the 2-component doublet with respect to ASV.

Particles have associated ***q*** as the intrinsic electrical charge which has magnitude q directly proportional to ASV b by (89). To accommodate ASV on the CNs, we are needed to construct a simple line bundle in **S**. The bundle construction is needed for performing ASV arithmetic independently of ψ. Thus according to Wigner's theorem, the group of continuous symmetry of particle with mass & electrical charge in epistemic universe would be U(1). Using the general scheme similar to that in last two subsections, we get the equation of most local dynamics for ASV interaction as

$$\frac{-k^2r^2c^2}{2m}\sum_j\left[\partial_j-\left(\frac{iq}{krc}\right)A_j\right]^2\psi+V\psi=irkc\left[\partial_t-\left(\frac{iq}{krc}\right)V_e\right]\psi \tag{112}$$

Again, this can be given the form

$$-\left(\frac{k^2r^2c^2}{2m}\right)\boldsymbol{D}_j\boldsymbol{D}_j\psi+V\psi=ikrc\boldsymbol{D}_0\psi \tag{113}$$

By defining $\boldsymbol{D}_\upsilon=\partial_\upsilon-\left(\dfrac{iq}{krc}\right)A_\upsilon$ (114)

Where, V_e is identified as A_0, and A_υ are referred as components of same 4-vector (isomorphically u(1) valued 1-form) potential. Thus in the epistemic universe, electromagnetic interaction follows the gauge principle. U(1) is the gauge group of the ASV interaction. Needless to say that the interaction caused due to ASV variation is nothing but the electromagnetic interaction.

XIII. LOCAL INTERACTIONS AND MASSIVE SSV INTERACTIONS

Each type of interaction is caused by variation in corresponding type of soul vector. The RSV, SASV & SSV were induced on CNs at the beginning. As time proceeded, RSVs caused collisions inducing mass as continuous variation of tangentially trapped RSV (causing gravity). Further collisions caused induction of ASVs on the CNs; simultaneous induction of spin causes ASV variation causing electromagnetic interaction. The gravity & electromagnetism (& kinematics on *M*) are due to rectilinear version of the soul vector (RSV) induced on the CNs. The angular & sangular versions of soul vector viz. SASV & SSV on a CN are constant until it is rotated to cause their change. The rotations of CNs inducing mass & electromagnetism would also have caused changes in SASV & SSV those were induced on the

CNs at the beginning. Such variation in SASV & SSV of CNs leads to the SASV & SSV demands causing the strong & weak interactions respectively. As for a particle ω & Ω are constant, rotation of spin circle and of mass circle happen simultaneously in constant proportional amounts.

The theory epistemically resulted to the fiber bundle structure of SM fields and their corresponding covariant derivatives. Ontically, the local portion of *M* is spatially three dimensional having time as an evolution parameter. Though the CNs are 4-balls of four isotropic dimensions, local surrounding of any CN in *M* is 3-dimensional spatial and has a time evolution dimension. Any soul vector demand would propagate through local spatial surrounding of the CN. Thus for the dynamics of interactions, change in the soul vector should be in cross-section of the CN & its surrounding i.e. projection of the 4-ball in form of spatial 3-ball. In other words, 3-dimensional spatial cross section (projection) of the CN has local existence, and any change in any version of the soul vector on the CN should live on the spatial 3-ball only (so that it can generate the opposite demanding package in its surrounding). Further, for locally possible interaction, at least two linearly independent soul vector directions are required on the 3-ball so that change in direction of the associated soul vector is possible locally. A 3-ball (local existence of the CN in its surrounding) is able to accommodate at least two linearly independent RSVs, ASVs & SASVs as their single element spans at most two dimensions. Thus local change in their directions is evident causing corresponding soul vector demand in *M*. But this is not the case with SSVs. Single SSV spans three dimensions, thus the 3-ball is amenable to accommodate single only and not any linearly independent SSVs. Hence locally there no manifestation of change in direction of SSV is possible in *M*.

An SSV locally on *M* spans entire spatial 3-ball. Hence the change in its direction should be caused by rotation transverse to the spatial space (& to the 3-ball). As discussed in [4], when direction of a sangular vector is changed in the universe, it results as change in magnitude and not in direction. This is because projection of a vector on the subspace changes its length when rotated transverse to the subspace (here, 3-ball is subspace of 4-ball; and surrounding of the CN is 3+1-dimensional, not 4-dimensional). Thus in the universe, change in magnitude of SSV happens even if it is constant on the CN. This change in magnitude of SSV would generate opposite SSV demanding package. But the SSV change is caused by the rotations simultaneous of mass & spin circles, transverse to spatial subset of *M*. Thus on the 3-ball, there should be also change in projections of mass & electric charge (or ASV) simultaneously. This implies that the SSV demanding package generation should come with demands for changes in mass & electric charge simultaneously.

The SSV is to be conserved in the local space, hence there is generation of SSV demanding package which would propagate locally on *M*. Mass & electric charge too should be conserved on *M*. Thus the unbalanced mass & electric charge should propagate around to get satisfied. As all these variations are generated in same time interval (however infinitesimal it may be) at same location (consolidated to be a point) in *M*, they simply generate a single package (can be considered as particle) demanding SSV, mass & electric charge. Global epistemic dynamics of such packages is already developed in section XII.

Without driving energy, any particle can travel at speed c only. And a particle with non zero mass can't travel at c. Therefore the massive SSV demanding package would propagate by consuming its mass as a fuel; hence this interaction would have certain range till which the fuel lasts. SSV demanding packages are massive (& charged) because the mass circle also rotates with that of SSV of the particle and their projection on spatial space changes.

We have discovered that a soul vector demanding package comes with mass & charge due to- the change in corresponding soul vector of the particle is transverse to the spatial surrounding. The vector change can be completely transverse to the spatial space or can be partially so (meaning the change being inclined) or can be within the spatial space. As an SSV spans the spatial space, its directional change is essentially completely transverse as elaborated before. On other hand changes in RSV, ASV & SASV can be inclined to the spatial space in general. Changes in ASVs & RSVs essentially exist within spatial space while SASV change may exist in any two of the four dimensions of the CN. This is because SASVs are induced at the beginning, thus SASV can be within the spatial projection or can be inclined. Hence there is scope for SASV changes to be inclined to spatial 3-ball which isn't possible for RSVs & ASVs. Further, as single SASV doesn't span 3-dimensional space, unlike SSV change its change can't be transverse to the 3-ball. Conclusively, SASV change due to rotation of a CN can be inclined to spatial 3-ball.

The extent of transverse change leads to corresponding change in projections of mass, electrical charge and spin, thereby the massive, charged & spinning soul vector demanding package. The transverse component of inclination quantifies rotation of the mass & spin circles transverse to the spatial 3-ball. It should cause corresponding change in projections of mass, spin & ASV (i.e. electrical charge) in spatial space. Such simultaneous change with change in the SASV leads to unbalanced SASV, mass, spin & charge, generating the SASV demanding package with mass, spin & electrical charge.

Unlike RSVs & ASVs, the SASV demanding package has possibility to be associated with mass, spin & charge. Amount of these properties depend on inclination of the SASV change with the local spatial subset of *M*. We don't have any model to fix the inclination; we can just expect it to be between 0^{o} to 90^{o}. In case of zero angle, SASV demanding package doesn't have mass, spin & charge. Such mechanism is possible with SASVs because they are induced on isotropic 4-ball, while it isn't possible with the RSVs & ASVs because they essentially exist within the three spatial dimensions. Theoretically, we have possibility for the massive, charged & spinning SASV demanding packages; we have no solid model for fixing of the inclination to specific angle or to zero. Entire change in SSV of a CN is transverse to spatial 3-ball, while some fraction (component) of change in SASV of a CN can be transverse to the spatial 3-ball. Therefore mass, electrical charge & spin of the SASV demanding package should be of very much lesser magnitudes than those of the SSV demanding package.

Unlike the ASV & RSV demanding packages, SSV & SASV demanding packages should be spinning. Thus the SSV & SASV demands associated with the package are changing due to the spinning. This would lead to continuous change in the SSV & SASV demands associated with the packages. In other words, the SSV & SASV demanding package themselves respectively generate the SSV & SASV demanding packages i.e. such packages undergo the interaction. Hence the SSV & SASV packages are self interacting. This self interaction is important for accepting the SU(2) & SU(3) groups of the corresponding gauge fields as discussed in section XII. The self interacting character of the SSV & SASV interactions can be identified with the non Abelian nature of the gauge groups. It is either coincidence or beauty of mathematics that the interactions having multiplets of the 4-spinor representations have self interacting demanding packages.

XIV. CHARACTERISTICS OF DIFFERENT INTERACTIONS

A. Strengths of interactions

A gross comparison of relative magnitudes of the different typed (versions of) vectors is obtained in [4]. If magnitude of rectilinear vector $\mathbf{s}_R$ is used to construct angular vector $\mathbf{s}_A$ on sphere of radius r, then the magnitudes are related as

$$\left|\mathbf{s}_A\right| = \frac{\left|\mathbf{s}_R\right|}{r} \tag{115}$$

Here $\mathbf{s}_A$ is SASV as it is trivial angular vector. The ASV too is angular vector, but it isn't trivial geometric angular vector. In fact it exist as different typed angular vector because of local physics, the product ω.s must be preserved to give c. Thus the magnitude of ASV may deviate from (115). Let the deviation be g', then relative magnitudes are given as

$$\left|\mathbf{s}'_A\right| = g'\frac{\left|\mathbf{s}_R\right|}{r} \tag{116}$$

Comparison of magnitudes of rectilinear & sangular vectors is obtained in [4] as

$$\left|\mathbf{s}_S\right| = \frac{g\pi\left|\mathbf{s}_R\right|}{2r} \tag{117}$$

Where, g is a deviation due to spherical area.

(115), (116) & (117) provide gross comparisons of magnitudes of equivalent different typed soul vectors. Different interactions are caused due to infinitesimal changes in corresponding typed soul vectors. Thus the $\mathbf{s}_R$ in the equalities is infinitesimal rectilinear change (of RSV) leading to corresponding infinitesimal changes SASV $\mathbf{s}_A$, ASV $\mathbf{s}'_A$& SSV $\mathbf{s}_S$ respectively. If one concerns radius of the CNs r, then weakness of infinitesimal RSV over infinitesimal SASV or ASV or SSV is evident. This explains weakness of gravity over other forces. Further g & g' make difference in strengths of the interactions. Thus all the interactions have different strengths; gravity is far weakest among all. Strengths of electromagnetic, weak & strong interactions are comparable. Now we don't have any model to explore the g & g', but can expect that these functions would result to deviations much smaller than the extreme r. This provides a good ontic foundation for explaining our observations and epistemic study in last century.

B. Mediators of Interactions

We can use conclusions from section XII to identify important classes of particles viz. bosons & fermions. Mediators of different interactions are the soul vector demanding packages quantifying corresponding potential fields. That we know as bosons are nothing but the generators of representation of the corresponding soul vector packages in epistemic universe **S**. Fermions are identified with the multiplets of mass & spin in **S** i.e. ψ. The ontic model matches well with the conventional epistemic model. Ontically a CN having induced fixed mass & different kinds of soul vectors is epistemically fermion. Ontically a specific soul vector demanding package generated by a particle that has no associated any fixed CN and propagates as unbalanced quantity is epistemically boson. Due to exclusive location of CNs in *M*, it is clear that no two fermions can exist at same location. But as the bosons are equivalent to just demanding packages of unbalanced quantities, they can exist at same location (at a point or at a CN) in multiple numbers. Like the induced vectors & scalars (demands) on a CN, multiple demanding packages can be induced at same location to be existing. This suggests the exclusion principle that no two fermions can exist at same location, but many bosons can exists at same location. The location in *M* is most primary example of quantum state. Hence we get the Pauli's exclusion principle, for the primary case.

Though spin is an important property in epistemic interpretation, ontically spin isn't referred for distinguishing bosons & fermions. Basically, bosons & fermions exist epistemically. Precisely, the particles associated with a fixed CN follow the exclusion principle; such particles are equivalent to epistemic fermions.

XV. DARK ENERGY REVISITED

Keep in mind that in universe there is most abundance of just CNs those aren't collided. These just CNs are nothing but the DE particles. Knowing this and assuming that a DE particle can't satisfy complete soul vector (RSV) demand but its certain fraction, mechanism of DE has to be revisited. DE particle can't be affected by ASV, SASV & SSV demands, it is affected by RSV demands due to piecewise rectilinear nature of M .To get gross idea of DE mechanism consider fig.7A where tiny gray colored dots are DE particles and larger black dots indicate mass clusters (i.e. clusters of massive particles). The RSV demands due to most dominant (i.e. closest) clusters on very few DE particles are signified by dotted arrows to give idea. An RSV demand from a mass pulls DE particle towards it. From fig.7A it can be seen that for most of the DE particles, resultant pull brings them along line joining nearest two mass clusters.

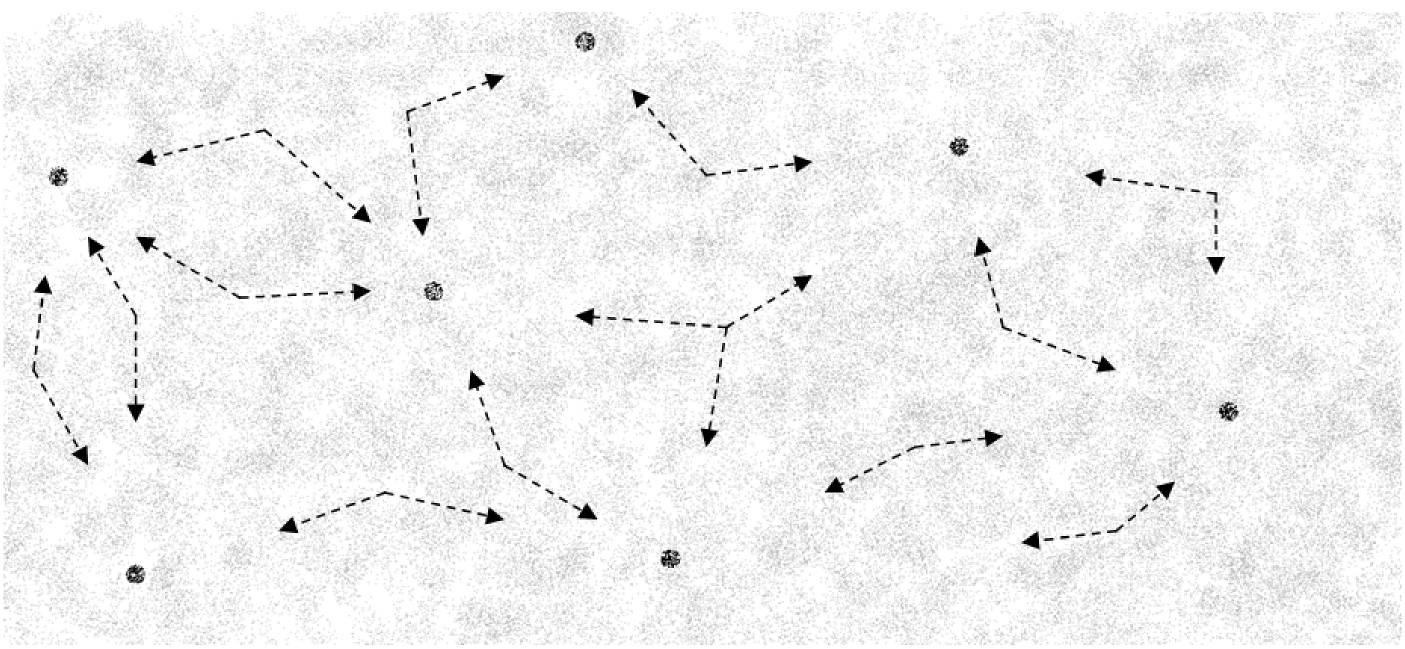

FIG.7A: Sample attraction on the DE particles in early stage universe

Therefore, after sufficient time. DE particles get distributed as grossly shown in fig. 7B. At such distribution, repulsion due to DE effect works dominantly where the DE particles are densely located (that is in between the mass clusters). As an effect, distance between the mass clusters increases resulting in expansion of the system. As there is highly dense occurrence of the DE particles between any two mass clusters, distance between all the clusters increases with time manifesting expansion of the system.

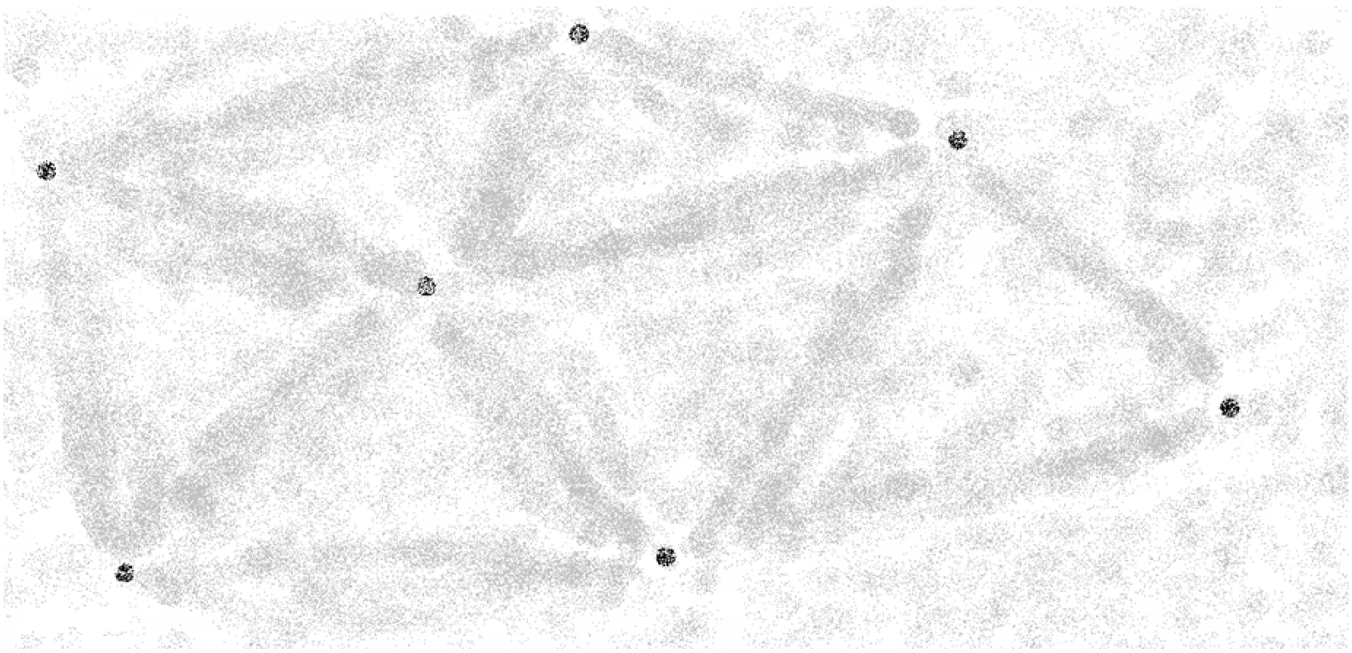

FIG.7B: Sample distribution of the DE particles in late stage universe between the mass clusters.

It seems that as DE particles are too abundant, expansion due to DE would dominate over gravitational attraction between masses and would lead to expansion (in other words, example of figure 7 would be applicable well by considering the black dots to be individual massive particles instead of the mass clusters). Then gravity wouldn't be detectable. Before concluding, let us see the details. Consider that the masses are distributed evenly in every direction i.e. a massive particle is surrounded by DE particle in all directions, then DE particles impact the massive particle from all directions and therefore there would be no net movement of the massive particle. This case is similar to any mass cluster surrounded by DE particles as in fig.7A. But due uneven distribution of the mass clusters, the situation subsequently gets altered as in fig.7B. Distribution of DE particles as in fig.7B is uneven and favors expansion. The uneven distribution would cause impacts due to the DE particles from some directions be dominant & not balanced by impact of DE particles from the opposite directions (as there are lesser DE particles in balancing directions). In such way the separation distance of mass cluster would increase. All this happens due to a uniform DE particle distribution as in fig.7A gives rise to a biased DE particle distribution as in fig.7B. This can not happen if about uniform distribution of DE particles remains as it is or there is no concentration of DE particles in specific directions. The 'biased' distribution of DE particles can be avoided if the masses are continuously moving or masses are placed densely (unlike fig.7A). Within galaxies and star systems, masses are continuously moving; and the masses are densely placed in planets & stars. Thus in both these cases DE effect is not considerably dominated in some directions & no expansion occurs. The biased DE distribution is possible where- around a mass cluster (or massive particle), other mass clusters remain in few directions only (for prolonged time). This is possible on largest cosmic scale (unlike within galaxies) and hence DE is considerable on largest cosmic scales of universe. DE particles do not have mass and hence they have no inertia, thus they move without trouble. DE effect can dominate when DE particles get distributed more densely between two mass clusters. Such biased distribution requires time i.e. DE dominates after formation of clusters & superclusters and additionally needing biased distribution of the surrounding DE particles. These necessities require time and hence proposed mechanism is possible real explanation that universe has expanded more in last half of its life [17]. At the smaller scales, masses are either moving or densely distributed. Thus there DE particles can't concentrate enough between the masses to facilitate their repulsion.

XVI. CONCLUSION

The theory proposed in the paper provides ontic interpretation of universe on fundamental scale. It provides interpretation of the physics underlying the quantum theories. It explains how the physical universe stems from nothing as such (before the creation). The creation resulted in consolidation of points in the CNs and a push on each CN. The push is identified as three different kinds of the vector i.e. RSV, SASV & SSV. Collision of CNs induces rotation giving raise to mass & gravity. Subsequent collision of massive CN results in the generation of spin, electric charge, ASV (& ASV variation too) and electromagnetic interaction. The rotations also cause variation in SASV & SSV associated with the CN inducing the strong & weak interactions respectively. The CNs those followed only one collision behave as dark matter. And those never collided lead to effect of dark energy.

General covariance at different CNs demands velocity c (rotation velocity of RSV **s** trapped tangentially at the massive CN) to be largest constant velocity. And mass attracts other mass with uniform acceleration due to the RSV variation, this makes the universe configuration as pseudo Riemannian manifold. The assumptions of relativity are revealed as the real/ontic phenomena by the theory.

Moving particle can be referred as a wave traced as it simultaneously rotates & translates. Epistemically, a particle is associated with an expectation wave in configuration space having the same periodicity as its rotation due to mass (rotation due to mass is the ontic periodicity adopted because rotation due to spin is secondary and gets accounted in analysis of momentum). It is found that the plank law & De Broglie hypothesis are special cases (v=c) of general. Also, the quantum mechanics is based on special epistemic case of velocity c of particles applied to unknown velocities of particles. With the special case, epistemic study of the interaction results in QFT with corresponding gauge groups. The epistemic universe **S** (abstract Hilbert space) is associated with every ontic universe *M* (the Riemannian manifold) as explained in [5, 6], and an observer simultaneously attains frame in both of them.

Different types of interaction occur due to existence of different types of a vector quantity- soul vector. Their mathematics is elaborated in [4]. The strengths of different typed interactions are amenable to be explained by the theory. We identify bosons with the soul vector demanding packages and fermions with the rotating CNs. A fermion is associated with an exclusive CN while boson is just a demanding package of unbalanced quantities which isn't associated with an exclusive CN. It suggests the exclusion principle for fermions and not for bosons. The theory explicitly discovered phenomena of entanglement, dark matter & dark energy in ontic manner. It so explained excess of matter over antimatter; it also accommodates for acceptable or reasonable proportions of dark matter, dark energy and the ordinary matter. Further, it nicely explains rapid expansion of universe at late stages and at larger cosmic scale.

Rigid formalism with corresponding mappings is built for the epistemic and ontic configurations. This easily leads to manifestation of real-abstract (ontic-epistemic) correspondence for the particle or universe. The reality behind the four component spinor too is elaborated, identification of the components of 4-spinor matches with the conventional interpretation.

The theory with consolidation explained in the paper leads to current physics (the standard model, relativity, dark matter & dark energy) from knowledge of nineteenth century by abandoning new foundations embarked in next age. By using classical physics & mathematics, this theory is built on its own in ontic manner which makes it special & explicit; while that development in last century is abstract & epistemic. The theory establishes ontic mechanisms underlying the epistemic understandings. It has the characteristics which the theory of everything should have. Now we have a model about existence of particles which results to assumptions of quantum mechanics and relativity. Most of the physics theories account just few phenomena/mechanisms and not all. For example, we get singularities in relativistic theories where the interactions other than gravity aren't concerned. At such instances, the theory of consolidation will be helpful. This theory provides all the ingredients of existence at fundamental level ontically (really, not abstractly) such as mass, electrical charge (ASV), color charge (intrinsic SASV), weak charge (intrinsic SSV), spin, dark matter, dark energy, interactions etc compatible with the known epistemic physics. This interpretation can be adopted for exploration where other physical phenomena are abandoned. For instance, we can apply the model of Consolidated Neighbourhoods & the intrinsic properties to the matter at black holes.

Starting point of the theory is- regard of fundamental (qurks, leptons & bosons) particles existing as pointlike. The theory provides a fruitful model for the particles instead of considering being pointlike, provides all the mechanisms those lead to the contemporary physics and gives explanation of several spooky faiths of the standard model. Further, it has made a logically sound assumption of consolidation of points in the CNs while the creation or big bang and explains the evolution explicitly; it is appreciable easily than abstract assumption of whole library of the particles & properties while creation.

Most of the mechanisms according to the consolidation are discussed in this paper. However, considering that universe is composed of CNs and not just points, theory of relativity should be configured. Constraint that a particle isn't pointlike but a 4-ball having radius r would lead to new consequences.

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