Quantum Field Theory in Accelerating Local Reference Frames v.2

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Abstract

Using the Dirac “square root” tetrads of the metric tensor are spin 1 fields that are intrinsically renormalizable for quantum gravity models. On the other hand both the c-number tetrads and the spin connections in our model are emergent from the eight gluon vacuum condensates of QCD that form in the inflationary phase transition. Their residual micro-quantum operator parts are the spin 1 quantum fields that are responsible for both the dark energy and the dark matter. Spread out dark energy with negative pressure comes from \( w = -1 \) random zero point virtual fermion-antifermion vacuum polarization loops that antigravitate because of the equivalence principle. Similarly, clumped dark matter comes from \( w = -1 \) random zero point virtual bosons of positive pressure that gravitate and is indistinguishable from \( w = 0 \) CDM for the distant observer. New conjectured expressions for important physical observables both at the micro and macro levels in rotating frames are presented. They need to be tested in the laboratory, for example, alleged anomalous gravity from rotating superconductors.

The approximately Minkowski metric \( \eta_{ij} \) covariantly unaccelerated Local Inertial Frame (LIF) indices are \( I,J,K,L \). Their curvilinear metric \( g_{\mu\nu} \) \textit{locally coincident} accelerating Local Non-Inertial Frame (LNIF) indices are \( \mu,\nu,... \). The internal symmetry electroweak-strong frame indices are \( a,b,c,... \). The four tetrad\(^3\) Cartan 1-forms\(^4\) that form an LIF\(^5\) basis are \( e^I \). The locally coincident LNIF basis is the set \( e^\mu \). You can think of these local frames as rigid material cages with detectors in 3D with a clock attached. For example, the NASA Pioneer space probe shown below is a good example of a local frame in Einstein’s General Relativity (GR).

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1 ISEP, sarfatti@pacbell.net
2 http://www.sciencedaily.com/releases/2006/03/060325232140.htm
4 http://en.wikipedia.org/wiki/Tetrad_(general_relativity)
6 http://en.wikipedia.org/wiki/Local_reference_frame
There are no g-forces on the LIF material structures (non-rotating by definition). There are g-forces on the LNIF material structures either from a non-gravity force or from conservation of angular momentum if the LNIF rotates about its center of mass (ignoring internal friction etc). The antisymmetric six spin connection Cartan 1-forms are $\omega^\nu$ whose 24 coefficients are

\[ \omega_{\mu}^\nu = \epsilon^v_{\mu} \partial_\nu \epsilon^{\nu v} + \epsilon^v_{\nu} \epsilon^{\sigma j}_{\mu} \Gamma_{\sigma j}^\nu = -\omega_{\nu}^\mu \quad (1.1) \]

where $\Gamma_{\sigma j}^\nu$ is the affine connection that encodes the effects of orbital rotation and spin as well as possible dynamically independent torsion fields in addition to curvature fields. I will always use Einstein’s 1915 GR “curvature” and am not using the constraint of “teleparallelism” as in the theory of Gennady Shipov.

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The dynamical parts of the tetrads and spin connections are the compensating gauge potentials from localizing the universal spacetime symmetry invariance groups of the global dynamical actions of all matter fields in the multiverse without exception. This is an expression of the strongest possible version of Einstein’s equivalence principle forced by the invariant light cone structure in the classical limit.

The Dirac matrices in the LNIF are

$$\gamma_{\mu} = \epsilon_{\mu} \gamma_i + \frac{1}{2} \omega^I_{\mu} [\gamma_i, \gamma_j]$$  \hspace{1cm} (1.2)

The new term I am guessing at is the second term on the RHS involving the spin connection and the commutator of the Dirac matrices in Minkowski spacetime.

The antisymmetric electroweak-strong gauge force field tensors in the LIF are

$$F^a_{ij} = \partial_i A^a_j - \partial_j A^a_i + gf^{a}_{bc} A^b_i A^c_j$$ \hspace{1cm} (1.3)

There internal multi-valued Goldstone phase “super-potential” Cartan 0-forms are $$\Theta^a$$

$$A^a_i = \partial_i \Theta^a$$ \hspace{1cm} (1.4)

The multi-valued property, e.g. phase jumps by $2\pi$ going around a stringy vortex defect in a superfluid, or the $4\pi$ jump wrapping around a point hedgehog monopole defect, make the field tensors non-zero.

Fig. 1. Magnetization pointing outwards in the space between two spherical enclosing surfaces. This is known as a hedgehog. David Thouless Topological QM book

These Goldstone phase singularities happen at nodes of the real Higgs field ground state order parameters where in effect

10 http://en.wikipedia.org/wiki/Gauge_theory
The Lie algebra of the internal electroweak-strong charges is

\[ [Q_a, Q_b] = f_{abc} Q_c \]  

(1.6)

The antisymmetric electroweak-strong field tensors in the LNIF are

\[
F^a_{\mu\nu} = \epsilon^I_\mu \epsilon^J_\nu F^a_{IJ} + \frac{f_{bc}^a}{2} \left[ \omega^I_\mu, \omega^J_v \right] F^b_{IJ} F^c_{KL} 
\]

(1.7)

again note my conjectured rotational-torsion field 2\textsuperscript{nd} term on the RHS of (1.6)

The gauge covariant partial derivative operator on matter fields in the LNIF is

\[
D_\mu = \gamma^I (\partial_\mu + iQ_a A^a_\mu) + \frac{1}{2} \omega^I_\mu \left[ [\partial_\mu, \partial_\nu] - [Q_a, A^a_\mu, Q_a, A^a_\nu] \right] 
\]

(1.8)

To get the Feynman propagators of leptons and quarks in the LNIF we need

\[ \gamma^I D_\mu = g^{\mu\nu} \gamma_v D_\mu \]  

(1.9)

The non-trivial parts \( B^I_\mu \) of the 16 tetrad coefficient maps connecting locally coincident LIFs and LNIFs are the compensating gauge potentials from localizing the universal 4-parameter translation group T4.

\[
e^I_\mu = \delta^I_\mu + B^I_\mu 
\]

(1.10)

\[
\| \delta^I_\mu \| = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} 
\]

(1.11)

\[
e^I = e^I_\mu e^\mu 
\]

(1.12)

\[
\omega^I = \omega^I_\mu e^\mu 
\]

(1.13)

My Ansatz that needs to be tested is

\[ B^I = \text{diag} M^{I\mu} \]  

(1.14)
\[
\omega^\mu = -\omega^\nu = \frac{1}{2} M^{[\mu,\nu]} \tag{1.15}
\]

\[
M^{\mu \nu} = d\Phi^I \wedge \Theta^J - \Phi^I \wedge d\Theta^J \tag{1.16}
\]

I conjecture that the unification of gravity with the electroweak-strong forces is at the level of the Cartan 0-form Goldstone phases of our post-inflation macroquantum coherent vacuum whose residual false vacuum zero point fluctuations is the missing 96% of the stuff of the world. Dark energy \(\sim 73\%\) is from virtual bosons with negative pressure. Dark matter \(\sim 23\%\) is from virtual fermion-antifermion loops with positive pressure. The connection of the internal forces with gravity is conjectured to be simply

\[
\bar{\Theta}^\nu = \sigma^I_\nu \Phi^I + \sigma^J_\nu \Theta^J \tag{1.17}
\]