The Arrow of Time and Effective Gravity in Modified Spinor Quantum Dynamics

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Content:

1. Universe as Ensemble of Fermionic Universes

Multi Universe wave function

$$\Psi = \begin{pmatrix} \Psi_1 \\ \Psi_2 \\ \Psi_3 \\ . \\ . \end{pmatrix}$$

Extended Dirac Equation with the complex parameter of evolution:

$$i\hbar\Psi_{,\tau} = \widehat{H}\Psi = (\widehat{\mathcal{E}} - \frac{\mathrm{i}\hbar}{2}\widehat{\mathfrak{I}})\Psi, \qquad \Psi_{,\tau^*} = 0$$

$$\tau = t - \frac{\mathrm{i}\hbar}{2}\beta$$

$$\hat{\mathfrak{E}} = \begin{pmatrix} E & 0 & 0 & & \\ 0 & E & 0 & \cdots & \cdot \\ 0 & 0 & E & & \\ & \cdot & & \cdot & \cdot \\ & \cdot & & \cdots & \cdot \end{pmatrix}, \quad \hat{\mathfrak{I}} = \begin{pmatrix} \gamma_1 & 0 & 0 & & \\ 0 & \gamma_2 & 0 & \cdots & \cdot \\ 0 & 0 & \gamma_3 & & \\ & \cdot & & \cdot & \cdot \\ & \cdot & & \cdots & \cdot \end{pmatrix}$$

$$\gamma_1 < \gamma_2 < \gamma_3 < \cdots = const$$

Matrix element for arbitrary operator $\hat{A}$:

$$< \Psi_1 \big| \hat{A} \big| \Psi_2 >= \int \bar{\Psi}_1 \gamma^4 \hat{A} \Psi_2 d^4 x$$

Average value

$$\bar{\hat{A}} = \frac{1}{Z} \int \bar{\Psi} \gamma^4 \hat{A} \Psi d^4 x$$

Statistical sum

$$Z(\beta) = \langle \Psi | \Psi \rangle = \int \bar{\Psi} \gamma^4 \Psi \, d^4 x - not\ a\ constant$$

Global Arrow of Time – only one Universe will survive asymptotically

$$\frac{d\bar{\mathfrak{I}}}{dt} \leq 0$$

2. Dynamic Reduction of the Additional Coordinates

Fully Analytic Model with Extra Dynamic Parameters

$$X^M = x^M - \frac{\mathrm{i}\hbar}{2}\mathrm{\beta}^{\mathrm{M}}$$

Master Dirac Equation

$$\Psi_{(k),X^4} + \left((\gamma^4)^{-1}\gamma^\mu \frac{\partial}{\partial X^\mu} + \frac{1}{2}\gamma_k\right)\Psi_{(k)} = 0, \qquad \Psi_{(\mathrm{k}),X^{M*}} = 0$$

$$\Psi = \Psi(X^M) = \begin{pmatrix} \Psi_{(1)} \\ \\ \vdots \\ \\ \end{pmatrix} + \begin{pmatrix} \\ \Psi_{(2)} \\ \vdots \\ \\ \end{pmatrix} + \begin{pmatrix} \\ \\ \Psi_{(3)} \\ \vdots \\ \\ \end{pmatrix} + \cdots + \begin{pmatrix} \\ \\ \vdots \\ \Psi_{(\mathrm{n})} \end{pmatrix}$$

Extreme Principle and Probabilistic Reduction of Dynamic Parameters

$$\rho = \rho(x^N, \beta^M)$$

$$\max_{\beta^M x^4} \rho = \rho\left(x^\mu, x^4_{max}(x^\mu), \beta^M_{max}(x^\mu)\right)$$

$$\beta^M = \beta^M_{max}(x^\mu) \quad \& \quad x^4 = x^4_{max}(x^\mu)$$

Thermodynamic mode = The evolution of the ensemble of Universes

Dynamically Reduced Wave Function

$$\psi(x^\mu) = \Psi[X^L(x^\mu)]$$

Reduced Master Dirac Equation (for each Universe)

$$\Psi_{,x^\mu} = (\mathrm{D}^{-1})^\mu_\nu \psi_{,x^\mu}$$

$$\mathrm{D}^\mu_\nu = \mathrm{X}^\mu_{,x^\nu} - \mathrm{X}^4_{,x^\nu}(\gamma^4)^{-1}\gamma^\mu$$

3. Effective Clifford Gravity

$$m_{tot}^2 = p^2\left(X^\lambda(x^\mu)\right) = \frac{1}{J^4}\bar{\Psi}\gamma^4\hat{p}^2\Psi$$

$$m_{geom}^2 = p^2(x^\mu) = \frac{1}{j^4}\bar{\psi}\gamma^4\hat{p}_\mu\hat{g}^{\mu\nu}\hat{p}_\nu\psi$$

$$m_{NR}^2 = m_{tot}^2 - m_{geom}^2$$

$$\hat{g}^{\mu\nu} = \frac{1}{2}\eta^{\alpha\beta}\left\{[(D^{-1})_\alpha^\mu]^+\gamma(D^{-1})_\beta^\nu + [(D^{-1})_\alpha^\nu]^+\gamma(D^{-1})_\beta^\mu\right\}$$

$$\gamma = \gamma^0\gamma^4$$

$$g^{\mu\nu}(x^\mu) = \frac{1}{j^4}\bar{\psi}\gamma^4\hat{g}^{\mu\nu}\psi$$

Metrics operator combines impact of all Universes, but asymptotically metric becomes metric of one survived Universe.

Rules for Riemannian tensors operations:

$$\hat{g}^{\mu\nu}\hat{g}_{\nu\lambda} = \delta^{\mu}_{\nu}\hat{I}$$

$$\hat{g}_{\mu\lambda} = a_{\mu\nu}I + b_{\mu\nu}\gamma^{5} + c_{\mu\nu|\alpha}\gamma^{\alpha} + d_{\mu\nu|\alpha}\lambda^{\alpha} + e_{\mu\nu|\alpha\beta}\Sigma^{\alpha\beta}$$

$$\nabla_{\mu}\hat{A}^{\nu} = \partial_{\mu}\hat{A}^{\nu} + \left\{\hat{\Gamma}^{\nu}_{\mu\lambda}, \hat{A}^{\lambda}\right\}$$

$$\hat{\Gamma}^{\tau}_{\lambda\nu} = \left\{\hat{\Gamma}_{\lambda\nu|\sigma}, \hat{g}^{\sigma\tau}\right\} = \{\partial_{\lambda}(\hat{g}_{\sigma\nu}) + \partial_{\nu}(\hat{g}_{\lambda\sigma}) - \partial_{\sigma}(\hat{g}_{\nu\lambda}), \hat{g}^{\sigma\tau}\}$$

$$\hat{R}^{\lambda}_{\mu\nu\rho} = \partial_{\mu}\hat{\Gamma}^{\lambda}_{\nu\rho} - \partial_{\nu}\hat{\Gamma}^{\lambda}_{\mu\rho} + \left\{\hat{\Gamma}^{\lambda}_{\mu\tau}, \hat{\Gamma}^{\tau}_{\nu\rho}\right\} - \left\{\hat{\Gamma}^{\lambda}_{\nu\tau}, \hat{\Gamma}^{\tau}_{\mu\rho}\right\}$$

$$R^{\lambda}_{\mu\nu\rho}(x^{\mu}) = \frac{1}{j^{4}}\bar{\psi}\gamma^{4}\hat{R}^{\lambda}_{\mu\nu\rho}\psi$$

4. Cosmological Solution

$$\Psi_{,x^i} = 0, \qquad i = 1,2,3$$

General solution:

$$\Psi = \Psi_+ + \Psi_-, \qquad \Psi_\pm = \frac{1}{\sqrt{2}}\begin{pmatrix} f_\pm \\ \mp i f_\pm \end{pmatrix}$$

and 2-columns $f_\pm$=$f_\pm(X^0 \mp X^4)$

Thermodynamic modes are:

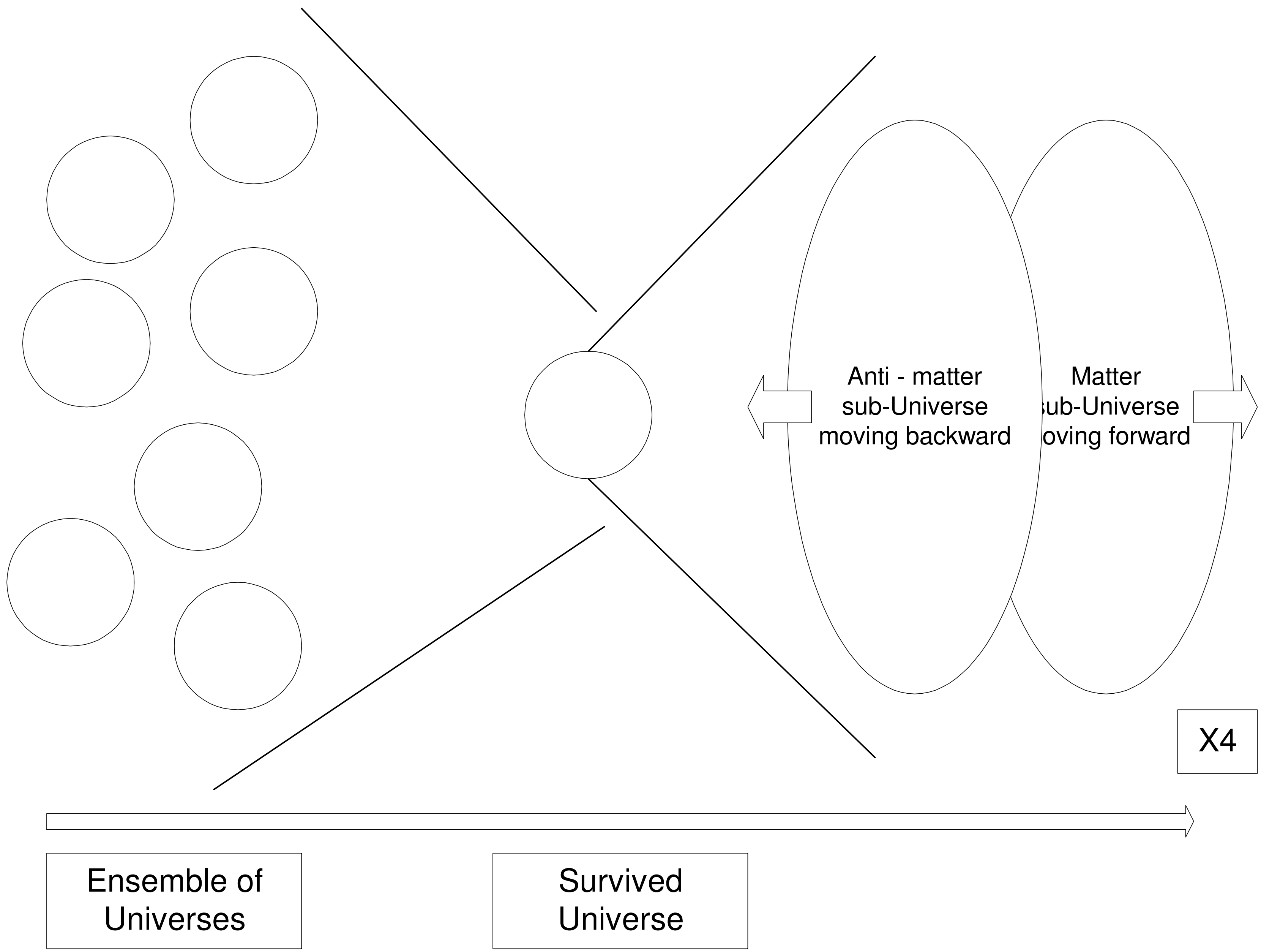
$$\max_{\beta^4,\beta^0,x^4} \rho = \rho\left(x^0, x^4_{max}(x^0), \beta^0_{max}(x^0), \beta^4_{max}(x^0)\right)$$

$$x^4 = x^4_{max}(x^0) \quad \& \quad \beta^4 = \beta^4_{max}(x^0) \quad \& \quad \beta^0 = \beta^0_{max}(x^0)$$

Particularly asymptotically for $x^4 \to \infty$:

$$x^4 \approx x^0$$

Hamiltonian time becomes equal to Minkowskian time of the survived Universe


Anti - matter
sub-Universe
moving backward
Matter
ub-Universe
oving forward
X4
Ensemble of
Universes
Survived
Universe

Metrics

$$\hat{g}^{\mu\nu} = \left[\frac{1-(\dot{x}^4)^2+2(\dot{x}^4)^4-2(\dot{x}^4)^3\hat{\Gamma}^0}{(1-(\dot{x}^4)^2)^2}\eta^{\mu\nu} + \frac{2}{1-(\dot{x}^4)^2}(\dot{x}^4)^2\delta_0^{\mu}\delta_0^{\nu}\right] +$$

$$+\frac{1+(\dot{x}^4)^2}{(1-(\dot{x}^4)^2)^2}\dot{x}^4(\delta_0^{\mu}\hat{\Gamma}^{\nu}+\delta_0^{\nu}\hat{\Gamma}^{\mu})$$

For

$$\dot{x}^4 \approx 1$$

$$\hat{g}_{\mu\nu} = \frac{1}{6}\left[\frac{3}{2}(\delta_{\mu}^{0}\hat{\Gamma}_{\nu}+\delta_{\nu}^{0}\hat{\Gamma}_{\mu})\dot{x}^4 - 2(\dot{x}^4)^2\hat{\Gamma}_{\mu}\hat{\Gamma}_{\nu} - \eta_{\mu\nu}\right](1+\dot{x}^4\hat{\Gamma}^0)$$

$$g_{\mu\nu}(x^0) = \frac{1}{j^4}\bar{\Psi}\gamma^4\hat{g}_{\mu\nu}\Psi$$

$$ds^2 = g_{\mu\nu}(x^0)dx^{\mu}dx^{\nu} = 2\omega_k dx^0 dx^k + \Xi\eta_{kl}dx^k dx^l$$

5. Conclusions

a. Multi Universe ensemble approach proposed as description of the Nature.

b. For such model the Arrow of Time appears as evolution from mixed initial data with all Universes to one Universe with the longest life time.

c. Five dimensional Dirac's equation with complex parameters plays a role of master equation for this system.

d. Dynamic reduction mechanism based maximum of the probability density defines evolution of ensemble of Universes. Arrow of Time defines which of them will survive.

e. Reduced theory is strongly non-linear with fixed parameters of anisotropy.

f. Metrics can be introduced through "geometrization" of mass distribution. Metrics is an operator based on Clifford algebra. All non-operator Riemannian structures can be calculated as coordinate realizations of the Riemannian ones.

g. Cosmological case is considered with Universe which consists of matter sub-Universe moving forward in time and anti-matter sub-Universe moving backward in time.