CPTM symmetry and cosmological constant in formalism of extended manifold

Bondarenko Sergey

sergeyb@ariel.ac.il

Physics Department
Ariel University
Israel

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An old idea: shadow Universe

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CPTM symmetry: doubling of degrees of freedom

- Consider two manifolds, A-manifold and B-manifold, with coordinates x and $\tilde{x}$ related by CPTM symmetry provided by CPTM transform:

$$q \to -\tilde{q}\,, r \to -\tilde{r}\, t \to -\tilde{t}\,, m_{grav} \to -\tilde{m}_{grav}\,, m_{inertial} \to \tilde{m}_{inertial}$$
$$\tilde{q}\,,\, \tilde{r}\,,\, \tilde{t}\,,\, \tilde{m}_{grav} > 0$$
$$CPTM(g_{\mu\nu}(x)) = \tilde{g}_{\mu\nu}(\tilde{x}) = g_{\mu\nu}(\tilde{x})$$

The transform relates the Eddington–Finkelstein (Kruskal–Szekeres) coordinates of the I and III regions of the Schwarzschild spacetime:

$$U = -\,e^{-\mathsf{u}/4M} \to \tilde{U} = e^{-\tilde{\mathsf{u}}/4\tilde{M}} = -\,U\,,\; V = e^{\mathsf{v}/4M} \to \tilde{V} = -\,e^{\tilde{\mathsf{v}}/4\tilde{M}} = -\,V$$
$$T = \frac{1}{2}\,(\,V + U\,) \to -\,T\,,\; R = \frac{1}{2}\,(\,V - U\,) \to -\,R$$

The CC assumed to arise as a result of interaction between the manifolds, it's value can be different for two manifolds but related by the CPTM symmetry:

$$CPTM(\Lambda) = \tilde{\Lambda}\,,\; CPTM(g_{\mu\nu}(x,\Lambda)) = \tilde{g}_{\mu\nu}(\tilde{x},\tilde{\Lambda})$$

Quantized scalar field: short example

- Consider a scalar field undergoes the CPTM transform:

$$\begin{aligned} CPTM(\phi(x)) &= CPTM\left(\int \frac{d^3\,k}{(2\pi)^{3/2}\,\sqrt{2\,\omega_k}}\left(\phi^-(k)\,e^{-\imath\,k\,x}+\phi^+(k)\,e^{\imath\,k\,x}\right)\right) = \\ &= \tilde{\phi}(\tilde{x}) = \int \frac{d^3\,k}{(2\pi)^{3/2}\,\sqrt{2\,\tilde{\omega}_k}}\left(\tilde{\phi}^-(k)\,e^{\imath\,k\,\tilde{x}}+\tilde{\phi}^+(k)\,e^{-\imath\,k\,\tilde{x}}\right) \end{aligned}$$

and

$$\left\{\begin{array}{l} \phi^-(k) \leftrightarrow \tilde{\phi}^-(k) \\ \phi^+(k) \leftrightarrow \tilde{\phi}^+(k) \end{array}\right. \to \left\{\begin{array}{c} [\tilde{\phi}^-(k)\,\tilde{\phi}^+(k')] = \delta^3_{k\,k'} \\ <\tilde{\phi}^+(k)\,\tilde{\phi}^-(k')>= -\delta^3_{k\,k'} \end{array}\right.$$

$$\left\{\begin{array}{l} <0|\,\phi^+ = 0 \\ \phi^+\,|0>\neq 0 \end{array}\right. \overset{CPTM}{\leftrightarrow} \left\{\begin{array}{l} \tilde{\phi}^+\,|0>= 0 \\ <0|\,\tilde{\phi}^+ \neq 0 \end{array}\right. ; \left\{\begin{array}{l} <0|\,\phi^- \neq 0 \\ \phi^-\,|0>= 0 \end{array}\right. \overset{CPTM}{\leftrightarrow} \left\{\begin{array}{l} \tilde{\phi}^-\,|0>\neq 0 \\ <0|\,\tilde{\phi}^- = 0 \end{array}\right.$$

The results:

$$\begin{aligned} <P^\mu> &= \int d^3\,k\,k^\mu\left(<\phi^+(k)\,\phi^-(k)>+<\tilde{\phi}^-(k)\,\tilde{\phi}^+(k)>\right) = 0 \\ & CPTM(G_F(x,y)) = -G_D(\tilde{x},\tilde{y}) \end{aligned}$$

A and B spinors in an external gravity field

- Lagrangian of extended manifold:

$$\begin{aligned}\mathcal{L} &= \mathcal{L}_A + \mathcal{L}_B = \mathcal{L}_A + \mathcal{CPTM}(\mathcal{L}_A) = \mathcal{L}_A + \overline{\psi}_B \left(\imath\gamma^a(-E_a^\mu)\partial_\mu + m\right)\psi_B = \\ &= \mathcal{L}_A - \overline{\psi}_B \left(\imath\gamma^a(E_a^\mu)\partial_\mu - m\right)\psi_B\end{aligned}$$

Gravity field is included with "negative" vierbein transform $(e,E)_A \rightarrow -(e,E)_B$:

$$\omega_{cab} \rightarrow \omega_{cab}\,,\ D_\mu \rightarrow D_\mu = \partial_\mu + \frac{1}{8}\,\omega_{\mu ab}\,[\gamma^a\gamma^b]$$

$$\begin{aligned}S &= S_A + S_B = \int d^4x_A\, e_A\, \overline{\psi}_A\, (\,\imath\, E_c^\mu\, \gamma^c\, D_\mu - m\,)\,\psi_A - \\ &- \int d^4x_B\, e_B\, \overline{\psi}_B\, (\,\imath\, E_c^\mu\, \gamma^c\, D_\mu - m\,)\,\psi_B\end{aligned}$$

We consider the linearized theory with symmetrical graviton:

$$\omega_{cab} = \partial_c\,(e_{1\,ab} - e_{1\,ba}) - \partial_a\,(e_{1\,cb} + e_{1\,bc}) + \partial_b\,(e_{1\,ca} + e_{1\,ac})$$

$$s_{cb} = \frac{1}{2}\,(\,e_{1\,cb} + e_{1\,bc}\,)\,,\ \ s_{cb} = s_{bc}$$

Quantization of B-spinor field

- The B-spinor field in this case is a replica of the A-field:

$$\psi(x)_{2B} = \int \frac{d^3p}{(2\pi)^{3/2}} \frac{1}{\sqrt{2\mathcal{E}p}} \sum_s \left(\left(\hat{\mathcal{M}} a^s_{\mathbf{p}} \right) u^s(p)\, e^{-\imath\, px} + \left(\hat{\mathcal{M}} b^{s\,\dagger}_{\mathbf{p}} \right) v^s(p)\, e^{\imath\, px} \right)$$

with

$$\begin{cases} \hat{\mathcal{M}}\, a^s_{\mathbf{p}} = c^s_{\mathbf{p}} \leftrightarrow a^s_{\mathbf{p}} \\ \hat{\mathcal{M}}\, b^s_{\mathbf{p}} = d^s_{\mathbf{p}} \leftrightarrow b^s_{\mathbf{p}} \end{cases} \rightarrow \begin{cases} \{ a^r_{\mathbf{p}}\, a^{s\dagger}_{\mathbf{k}} \} \rightarrow \{ c^r_{\mathbf{p}}\, c^{s\dagger}_{\mathbf{k}} \} = -\,\delta^3_{p\,k}\, \delta^{rs}\,, \quad < 0|c^r_{\mathbf{p}} = 0 \\ \{ b^r_{\mathbf{p}}\, b^{s\dagger}_{\mathbf{k}} \} \rightarrow \{ d^r_{\mathbf{p}}\, d^{s\dagger}_{\mathbf{k}} \} = -\,\delta^3_{p\,k}\, \delta^{rs}\,, \quad < 0|d^r_{\mathbf{p}} = 0 \end{cases}$$

and

$$P^\mu = \sum_s \int d^3k\, k^\mu \left(a^{s\dagger}_{\mathbf{p}} a^s_{\mathbf{p}} + b^{s\dagger}_{\mathbf{p}} b^s_{\mathbf{p}} + c^s_{\mathbf{p}} c^{s\dagger}_{\mathbf{p}} + d^s_{\mathbf{p}} d^{s\dagger}_{\mathbf{p}} \right)\,, \quad < 0|\, P^\mu\, |0 > = 0$$

Quantum propagator for B-spinor field is again the Dyson's one:

$$\tilde{S}_F(x-y) = -\left(\imath \hat{\partial}_x + m \right) \int \frac{d^4k}{(2\pi)^4} \frac{e^{-\imath\, k\,(x-y)}}{k^2 - m^2 - \imath\varepsilon}$$

$$\left(\imath\, \hat{\partial}_x - m \right) \tilde{S}_F(x,y) = -\,\delta^4(x-y)$$

One loop effective action for A,B-manifolds

- The effective action construction:

$$\psi_{A,B} \to \psi_{A,B\,cl} + \chi_{A,B}\,.$$

For the weak gravity limit

$$s_{ab} = \bar{s}_{ab} - \frac{1}{2}\,\eta_{ab}\,\bar{s}\,, \;\; \partial_a\,\bar{s}^a_b = 0$$

Tadpole contributions to Γ effective action or vacuum contributions to momentum-energy tensor (Euclidean space):

$$\Gamma_1 = \imath\,S^E_{FR}(0)\int d^4x\left(-\imath\,(\delta^{\,\mu}_c\,\partial_\mu s - \eta^{\mu\nu}\partial_\mu s_{c\nu})\,\gamma^c + \frac{\imath}{2}\,(\partial_b s_{\,ca} - \partial_a s_{\,cb})\,\gamma^c\,\gamma^a\,\gamma^b - m\,s\right)$$

$$\Gamma_1(p_f) = -4\,\imath\,m^2\,G^E_{Sc.Reg.}(0)\int d^4x\,s(x)$$

$$\Gamma_{1A} + \Gamma_{1B} = 0$$

Two-legs contributions to Γ or tadpole contributions to momentum-energy tensor

$$\Gamma_{2A} + \Gamma_{2B} = 0$$

One-loop spinor and gravity actions together:

- One-loop spinor action:

$$\Gamma(\overline{\psi},\psi,s) \;=\; \Gamma_A(\overline{\psi}_A,\psi_A,s) \;+\; \Gamma_B(\overline{\psi}_B,\psi_B,s) \;=$$
$$= \int d^4x_A\,\overline{\psi}_A\,M_1(x_A)\,\psi_A \;-\; \int d^4x_B\,\overline{\psi}_B\,M_1(x_B)\,\psi_B \;-$$
$$- \int d^4x_A\,d^4y_A\,\overline{\psi}_A(x_A)\,M_1(x_A)\,S_F(x_A,y_A)\,M_1(y_A)\,\psi_A(y_A) \;-$$
$$- \int d^4x_B\,d^4y_B\,\overline{\psi}_B(x_B)\,M_1(x_B)\,S_D(x_B,y_B)\,M_1(y_B)\,\psi_B(y_B)$$

Gravity action:

$$S_{gr} = -m_p^2 \int_{-\infty}^{\infty} dt_A \int d^3x\,\sqrt{-g_A}\,R(x) - m_p^2 \int_{-\infty}^{\infty} dt_B \int d^3x\,\sqrt{-g_B}\,R(x)$$

with

$$m_p^2 \;=\; \frac{1}{16\pi G} \;=\; \frac{2}{\kappa^2}\,, \quad g_B(x_B) \;=\; CPTM\,(g_A(x_A))$$

General action:

$$S \;=\; \Gamma(\overline{\psi},\psi,s) \;+\; S_{gr}$$

General set-up for the gravity field:

- Weak gravity limit, mostly general set-up:

$$g^{A}_{\mu\nu}(x) \,=\, g^{A\,0}_{\mu\nu}(x) \,+\, h^{A}_{\mu\nu}(x)\,;$$
$$g^{B}_{\mu\nu}(y) \,=\, g^{B\,0}_{\mu\nu}(y) \,+\, h^{B}_{\mu\nu}(y)\,;\,.$$

$$h_{\mu\nu} \,=\, \overline{h}_{\mu\nu} \,-\, \frac{1}{2}\,\eta_{\mu\nu}\,\overline{h}\,,\;\; \partial_{\mu}\,\overline{h}^{\mu}_{\nu} \,=\, 0\,,$$

$$\begin{aligned}
\Gamma \;\;=\;\; & \frac{m_p^2}{4}\int d^4x\,\overline{h}^{\mu\nu}_{A}\,G^{-1}_{A}\,\overline{h}^{A}_{\mu\nu} \,+\, \frac{m_p^2}{4}\int d^4x\,\overline{h}^{\mu\nu}_{B}\,G^{-1}_{B}\,\overline{h}^{B}_{\mu\nu} \,+\, \int d^4x\,\overline{h}^{\mu\nu}_{A}\,T_{\mu\nu\,A} \,+ \\
+ \;\; & \int d^4x\,\overline{h}^{\mu\nu}_{B}\,T_{\mu\nu\,B} \,+\, \eta_{\mu\nu}\int d^4x\,\overline{h}^{\mu\nu}_{A}\,\Lambda_{0\,A} \,+\, \eta_{\mu\nu}\int d^4x\,\overline{h}^{\mu\nu}_{B}\,\Lambda_{0\,B} \,- \\
- \;\; & \frac{1}{2}\int d^4x\int d^4y\,\overline{h}^{\mu\nu}_{A}(x)\,M^{1\,AA}_{\mu\nu\,\rho\sigma}\,\overline{h}^{\rho\sigma}_{A}(y) \,-\, \frac{1}{2}\int d^4x\int d^4y\,\overline{h}^{\mu\nu}_{B}(x)\,M^{1\,BB}_{\mu\nu\,\rho\sigma}\,\overline{h}^{\rho\sigma}_{B}(y) \,- \\
- \;\; & \frac{1}{2}\int d^4x\int d^4y\,\overline{h}^{\mu\nu}_{A}(x)\,M^{1\,AB}_{\mu\nu\,\rho\sigma}\,\overline{h}^{\rho\sigma}_{B}(y) \,-\, \frac{1}{2}\int d^4x\int d^4y\,\overline{h}^{\mu\nu}_{B}(x)\,M^{1\,BA}_{\mu\nu\,\rho\sigma}\,\overline{h}^{\rho\sigma}_{A}(y)
\end{aligned}$$

The $M^{1\,I\,J}_{\mu\nu\,\rho\sigma}(\overline{\psi},\psi)$ here are vertices of effective interaction between $I = A, B$ and $J = A, B$ gravity fields. The cosmological constants $\Lambda_{A,B}$ appears here as some terms in the effective action.

General set-up: propagators and dark matter

- Green's function of the framework:

$$\frac{m_p^2}{2}\begin{pmatrix} G_A^{-1} - \frac{2}{m_p^2}\,M_1^{AA} & -\frac{2}{m_p^2}\,M_1^{AB} \\ -\frac{2}{m_p^2}\,M_1^{BA} & G_B^{-1} - \frac{2}{m_p^2}\,M_1^{BB} \end{pmatrix}\begin{pmatrix} G_{AA} & G_{AB} \\ G_{BA} & G_{BB} \end{pmatrix} = I$$

The G_{AB} and G_{BA} propagators here are analog of the Wightman propagators $S_>$ and $S_<$ in the Schwinger-Keldysh technique. The Green's function for A-manifold:

$$G_A^{-1}\,G_{0\,AA} \,=\, \frac{2}{m_p^2}\,\delta_{AA}\,,\; G_B^{-1}\,G_{0\,BA} \,=\, 0\,,\; G_A^{-1}\,G_{0\,AB} \,=\, 0\,;$$

$$G_{AA} \,=\, G_{0\,AA} + \int G_{0\,AA}\,M^{1\,AA}\,G_{AA} + \int G_{0\,AA}\,M^{1\,AB}\,G_{BA} +$$

$$+ \int G_{0\,AB}\,M^{1\,BA}\,G_{AA} + \int G_{0\,AB}\,M^{1\,BB}\,G_{BA}\,.$$

The propagator is modified-"dark" matter effect. The gravitational field:

$$h_I \,=\, h_{0\,I} \,-\, \frac{2}{m_p^2}\int G_{IJ}\,\frac{\delta\,\Gamma_{int}}{\delta h_J} + \xi_I\,;\;\; G_I^{-1}h_{0\,I} \,=\, 0\,;\;\; I,J = A,B\,.$$

Cosmological constant appearance: first variant

- We have to define the connection between s and h fields. In an analog of the Schwinger-Keldysh like formulation:

$$g^{A,B}_{\mu\nu}(x) = g^{A,B\,0}_{\mu\nu}(x) + h^{A,B}_{\mu\nu}(x)\,, \;\; s_A = \frac{h_A}{2}\,, \;\; s_B = \frac{h_B}{2}$$

To leading order precision CC is:

$$\Lambda_A = \frac{1}{m_p^2}\,\frac{\delta\,\Gamma}{\delta\,\overline{h}_A}\Big|_{\overline{h}_A=0} = \frac{m}{4\,m_p^2}\,\overline{\psi}_A\,\psi_A\,, \;\; \Lambda_B = \frac{1}{m_p^2}\,\frac{\delta\,\Gamma}{\delta\,\overline{h}_B}\Big|_{\overline{h}_B=0} = -\frac{m}{4\,m_p^2}\,\overline{\psi}_B\,\psi_B$$

$$m\,\overline{\psi}_{A,B}\,\psi_{A,B} = \left(T^{\mu}_{0\,\mu}\right)_{A,B}$$

The one loop-contributions in this case are not fully canceled:

$$\begin{aligned} s_A &= \frac{h_A}{2} = \frac{1}{2}\,h_{0\,A} - \int G_{AA}\,\Lambda_{0\,A} + \cdots \\ s_B &= \frac{h_B}{2} = \frac{1}{2}\,h_{0\,B} - \int G_{BB}\,\Lambda_{0\,B} + \cdots \end{aligned}$$

even for $h_{0\,A} = h_{0\,B}$, to next order the fields are not the same.

Cosmological constant appearance: second variant

- Vierbein gravity fields are the same for the matter fields:

$$g^{A,B}_{\mu\nu}(x) = g^{A,B\,0}_{\mu\nu}(x) + h^{A,B}_{\mu\nu}(x)\,, \;\; \overline{s}_{\mu\nu} = \frac{1}{2}\,\overline{h}_{\mu\nu} = \frac{1}{4}\left(\overline{h}^{A}_{\mu\nu} + \overline{h}^{B}_{\mu\nu}\right)$$

with action:

$$\begin{aligned}
\Gamma \; = \; & \frac{m_p^2}{4}\int d^4x\,\overline{h}^{\mu\nu}_{A}\,G^{-1}_{AA}\,\overline{h}^{A}_{\mu\nu} + \frac{m_p^2}{4}\int d^4x\,\overline{h}^{\mu\nu}_{B}\,G^{-1}_{BB}\,\overline{h}^{B}_{\mu\nu} + \int d^4x\,\overline{h}^{\mu\nu}_{A}\,T_{\mu\nu\,A} + \\
+ \; & \int d^4x\,\overline{h}^{\mu\nu}_{B}\,T_{\mu\nu\,B} + \eta_{\mu\nu}\int d^4x\,\overline{h}^{\mu\nu}_{A}\,\Lambda_{0\,A} + \eta_{\mu\nu}\int d^4x\,\overline{h}^{\mu\nu}_{B}\,\Lambda_{0\,B} - \\
- \; & \frac{1}{2}\int d^4x\int d^4y\,\overline{h}^{\mu\nu}_{A}(x)\left(M^{1\,AA}_{\mu\nu\,\rho\sigma} + M^{1\,BB}_{\mu\nu\,\rho\sigma}\right)_{xy}\,\overline{h}^{\rho\sigma}_{A}(y) - \\
- \; & \frac{1}{2}\int d^4x\int d^4y\,\overline{h}^{\mu\nu}_{B}(x)\left(M^{1\,AA}_{\mu\nu\,\rho\sigma} + M^{1\,BB}_{\mu\nu\,\rho\sigma}\right)_{xy}\,\overline{h}^{\rho\sigma}_{B}(y) - \\
- \; & \frac{1}{2}\int d^4x\int d^4y\,\overline{h}^{\mu\nu}_{A}(x)\left(M^{1\,AA}_{\mu\nu\,\rho\sigma} + M^{1\,BB}_{\mu\nu\,\rho\sigma}\right)_{xy}\,\overline{h}^{\rho\sigma}_{B}(y) - \\
- \; & \frac{1}{2}\int d^4x\int d^4y\,\overline{h}^{\mu\nu}_{B}(x)\left(M^{1\,AA}_{\mu\nu\,\rho\sigma} + M^{1\,BB}_{\mu\nu\,\rho\sigma}\right)_{xy}\,\overline{h}^{\rho\sigma}_{A}(y) - \\
- \; & \frac{1}{2}\int d^4x\int d^4y\,\overline{h}^{\mu\nu}_{A}(x)\,M^{1\,AB}_{\mu\nu\,\rho\sigma}\,\overline{h}^{\rho\sigma}_{B}(y) - \frac{1}{2}\int d^4x\int d^4y\,\overline{h}^{\mu\nu}_{B}(x)\,M^{1\,BA}_{\mu\nu\,\rho\sigma}\,\overline{h}^{\rho\sigma}_{A}(y)
\end{aligned}$$

Cosmological constant appearance: second variant

- CC we have in this case:

$$\Lambda_{0A} = \Lambda_{0B} = \frac{1}{8}\,\frac{m}{m_p^2}\,\left(\overline{\psi}_A(z)\,\psi_A(z) - \overline{\psi}_B(z)\,\psi_B(z)\right) = \frac{1}{8\,m_p^2}\,\left(T^{\mu}_{A\,\mu} - T^{\mu}_{B\,\mu}\right)$$

There are two possibilities, the trivial one with parallel arrows of time's flow

$$T^{\mu}_{B\,\mu} = T^{\mu}_{A\,\mu}$$

and with opposite time directions for the A, B manifolds

$$t_{A,B} = \frac{T}{2} \pm t\,; \quad \zeta = t/T$$

$$\Lambda_{0A} = \frac{1}{8m_p^2}\left(T^{\mu}_{A\,\mu}(\frac{T}{2} + t) - T^{\mu}_{B\,\mu}(\frac{T}{2} - t)\right) \approx \frac{1}{4Tm_p^2}\left(\frac{\partial T^{\mu}_{0A\,\mu}}{\partial \zeta} + \frac{\partial T^{\mu}_{0B\,\mu}}{\partial \zeta}\right)\,t$$

The cosmological constant is changing with time and rate of the the change is defined by the change of the trace of the energy-momentum tensor, which is due a new matter creation and/or annihilation in our Universe.

Cosmological constant appearance: third variant

- We can consider the mutual weak field as well:

$$g_{\mu\nu}^{A,B}(x) = g_{\mu\nu}^{A,B\,0}(x) + \frac{1}{2}\left(h_{\mu\nu}^{A}(x) + h_{\mu\nu}^{B}(x)\right)\,,\;\; \bar{s}_{\mu\nu} = \frac{1}{2}\,\overline{h}_{\mu\nu} = \frac{1}{4}\left(\overline{h}_{\mu\nu}^{A} + \overline{h}_{\mu\nu}^{B}\right)$$

with action

$$\begin{aligned}\Gamma &= \frac{m_p^2}{16}\int d^4x\,\overline{h}_A^{\mu\nu}\left(G_{AA}^{-1} + G_{BB}^{-1}\right)\overline{h}_{\mu\nu}^{A} + \frac{m_p^2}{16}\int d^4x\,\overline{h}_B^{\mu\nu}\left(G_{BB}^{-1} + G_{AA}^{-1}\right)\overline{h}_{\mu\nu}^{B} + \\ &+ \frac{m_p^2}{8}\int d^4x\,\overline{h}_A^{\mu\nu}\left(G_{AA}^{-1} + G_{BB}^{-1}\right)\overline{h}_{\mu\nu}^{B} + \int d^4x\,\overline{h}_A^{\mu\nu}\,T_{\mu\nu\,A} + \cdots\end{aligned}$$

There is a special free fields propagator arises here, for the particular types of G_{AA}^{-1} and G_{BB}^{-1} it can describes a theory without free asymptotic gravitons, similarly to Wheeler-Feynman propagator. The cosmological constant is this case is the same (to LO) as in the second variant, but propagator's structure ("dark" matter issue) is different from the previous case.

Conclusion:

- The CPTM symmetry defines an additional manifold populated by negative mass (gravitational) matter, the number of matter fields is doubling (at least).
- For the same external gravitational "legs" attached to the loop diagrams, there is a cancellations of the particular one-loop contributions to the general effective action (momentum-energy tensor) of the extended manifolds occurs. For the full cancellation, the mechanism requires an introduction of the unified weak gravity field for A and B manifolds, otherwise the only particular cancellation takes place.
- Without special "mixing" mechanisms, the A and B manifolds do not interact. The interactions are due the like Schwinger-Keldysh non-diagonal Green's functions or/and introduction of the interactions of the matter of both separated manifolds with two weak gravity fields in Dirac equations. There is an option for the single unified gravity field for both manifolds exists as well of course.
- On the classical level there are th eoptions for the CC to be equal or to the trace of the matter's momentum-energy tensor for each manifold separately or CC van be equal to the difference of the matter's momentum-energy tensor of the A and B manifolds.

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- Without special "mixing" mechanisms, the A and B manifolds do not interact. The interactions are due the like Schwinger-Keldysh non-diagonal Green's functions or/and introduction of the interactions of the matter of both separated manifolds with two weak gravity fields in Dirac equations. There is an option for the single unified gravity field for both manifolds exists as well of course.
- On the classical level there are th eoptions for the CC to be equal or to the trace of the matter's momentum-energy tensor for each manifold separately or CC van be equal to the difference of the matter's momentum-energy tensor of the A and B manifolds.

Conclusion:

- The dark matter appears in the approach inevitably in the form of the gravity propagator modification due the B manifold influence.
- The approach is falsifiable, namely each from the variants provides different values of cosmological constant and different ways of propagators modifications The cosmological constant and propagators can be calculated at least to one-loop precision.
- The interesting issue is about the renormalizability properties of the model-can also help to choose the particular scheme.

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