

On the one model of modified gravity

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Modern Accelerated Expansion of the Universe

- Λ
problem:
the value of dark energy density

- beyond Λ ?
Some new physics in the **Infrared** (at low energies)
 - quintessence
 - ...
 - spin-2 particle instead or
besides the standard graviton

Infrared Modification

$$\frac{1}{k^2 + m^2} \quad - \quad \text{new behaviour in } k^2 \rightarrow 0 \text{ limit}$$

Problems of massive spin-2 particle theories:

- new pathologic mode in spectrum - the ghost Boulware-Desert mode
- tachions
- there is a finite fatal difference in predictions from those of general relativity at the linear level (van Dam-Veltman-Zakharov discontinuity) - in some theories could be cured by Vainstein mechanism



The Model

The theory with Lorentz- and gauge-invariant second-order lagrangian with both vierbein e_i^μ and connection $A_{ij\mu}$ considered as independent fields.

$$L = M_{pl}^2 R + \frac{3}{2} \tilde{\alpha} (F - R) + c_3 F_{ij} F_{ij} + c_4 F_{ij} F_{ji} + c_5 F^2 + c_6 (\epsilon \cdot F)^2$$

$M_{pl}^2 R = L_{EH}$ – Einstein-Hilbert action;

$$R = e_k^\mu e_l^\nu (\partial_\mu \omega_{ij\nu} - \partial_\nu \omega_{ij\mu} + \omega_{im\mu} \omega_{mj\nu} - \omega_{jm\mu} \omega_{mi\nu})$$

- Riemann curvature defined only by vierbein e_i^μ ,

$\omega_{ij\mu}$ - Riemannian connection;

$$F_{ijkl} = e_k^\mu e_l^\nu (\partial_\mu A_{ij\nu} - \partial_\nu A_{ij\mu} + A_{im\mu} A_{mj\nu} - A_{jm\mu} A_{mi\nu})$$

- curvature tensor defined by connection $A_{ij\mu}$;

Linearized theory on the Minkovsky background



- All modes in linearized theory on the Minkovsky background are neither ghost nor tachyonic. 😊
- vDVZ discontinuity takes a place. Vainstein mechanism didn't studied yet. 😞
- The interaction is mediated by both massless and massive spin-2 fields, with relative strength being a free parameter in our model - Infrared Modification. 😊

Self-accelerating solution

Field equations of the model are satisfied if one uses the ansatz in the form:

$$e_{\mu}^i = \delta_{\mu}^i e^{-\lambda t} \longrightarrow \text{it's a de Sitter metric}$$

$$A_{ij\mu} :$$

$$A_{0ab} = e^{-\lambda t} f \delta_{ab}$$

$$A_{abc} = e^{-\lambda t} g \epsilon_{abc}$$

$$f, g, \lambda = \text{const}$$

It's a de Sitter space-time with non-zero torsion.

So, this theory has the self-accelerating space-time as a solution of its field equation. 😊

Linearized theory on the self-accelerating background



- There are no ghost Boulware-Desert mode... 😊
- ... Full investigation of this theory at self-accelerating background is in progress.

Thanks!

Two words about torsion

$$A_{ijk} - A_{ikj} = T_{ijk} - \text{torsion tensor}$$

Torsion tensor equals to zero in General Relativity, because the non-zero torsion tensor breaks the equivalence principle.

The Equivalence Principle: in the gravitational field one can choose the locally inertial reference frame.