December 13, 2021

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On Non-local Modified Gravity

Many significant gravitational phenomena have been predicted and discovered by General Relativity (GR), despite of all the successes and many nice theoretical properties, GR is not complete theory of gravity. One of actual approaches towards more complete theory of gravity is its nonlocal modification.

We consider nonlocal modification of the Einstein theory of gravity in framework of the pseudo-Riemannian geometry. The nonlocal term has the form $\mathcal{H}(R)\,\mathcal{F}(\Box)\,\mathcal{G}(R)$, where $\mathcal{H}$ and $\mathcal{G}$ are differentiable functions of the scalar curvature R, and $\mathcal{F}(\Box) = \sum_{n=0}^{\infty} f_n\,\Box^n$, where f_n are analytic functions of the d'Alembert operator $\Box$. Our motivation to modify gravity in an analytic nonlocal way comes mainly from string theory, in particular from string field theory and p-adic string theory.

Using calculus of variations we derived the corresponding equations of motion. The variation of action is induced by variation of the metric tensor $g_{\mu\nu}$. We consider several models of the above mentioned type, as well as the case when the scalar curvature is constant. Moreover, we consider space-time perturbations of the de Sitter space. It was shown that gravitational waves are described in the class of nonlocal models $\mathcal{H}(R)\,\mathcal{F}(\Box)\,\mathcal{G}(R)$, with respect to Minkowski metric by the same equations as in general relativity.

Recently, we deal with the cases where:

(1) $\mathcal{H}(R) = \mathcal{G}(R) = R - 4\,\Lambda$, and

(2) $\mathcal{H}(R) = \mathcal{G}(R) = \sqrt{R - 2\,\Lambda}$.

Specially, we paid our attention to the case (2) with scaling factor of the form $a(t) = A\,t^{\frac{2}{3}}\,e^{\frac{\Lambda}{14}\,t^2}$, and we find some new cosmological solutions, and we test validity of obtained solutions with experimental data.

SCIENTIFIC SEMINAR
"DIFFERENTIAL GEOMETRY AND APPLICATIONS"

headed by Academician of RAS Anatoly T. Fomenko

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