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Proceedings

On the Conformal Invariant Cosmology

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Abstract: In construction of the conformal invariant Lagrangian we restrict ourselves to the so-called Quadratic Gravity. Then, in the Riemannian geometry there exist only one suitable combination, namely, the square of the Weyl tensor (completely traceless part of the curvature tensor). The corresponding left-hand side of the field equations, the Bach tensor, is linear in the Weyl tensor itself and its second covariant derivatives. But, for any homogeneous and isotropic cosmological spacetime (i.e., Robertson-Walker metric with arbitrary scale factor) the Weyl tensor is identically aero. Thus, any cosmological metric is the vacuum solution of the Weyl gravity in the framework of the Riemannian geometry – no matter at all! In 1919 Hermann Weyl invented a new geometry, which is now called the Weyl geometry. He introduced some 1-form and incorporated it into the connections by demanding that the new covariant derivative of the metric tensor coefficient equals this 1-form times that very coefficient. Then, he showed that in order these new connections to be conformal invariant, the 1-form must behave under the conformal transformation of the metric as the gauge field. It was the great discovery! How about the cosmology in the Weyl geometry?

We started with construction the Lagrangian for the single particle moving in the given gravitational field in the Weyl geometry and discovered that there may exist some new interaction, absent in the Riemannian geometry (and, particularly, in General Relativity). This is due to the existence of the yet another invariant, namely, the contraction of the 1-form with the particle four-velocity vector. We called it "the invariant B". And we were able to incorporate it into the Lagrangian for the perfect fluid. The cosmological principle requires that the Weyl 1-form should have only one (temporal) non-vanishing component depending only on the time coordinate. Hence, it can be removed by a suitable conformal transformation (also depending only on time). In such a gauge all possible functions of our new invariant B are converted into the set of some constants. The corresponding solutions we called "the basic solutions". Given the basic solutions, the general ones are obtained by the arbitrary time-depending conformal transformation of both metric tensor and the 1-form. The important role in the existence of the non-trivial cosmological solutions is played by the possibility of the particle creation. The important problem is the comparison with the observations. By doing that and extracting some consequences we are using the cosmological equations of General Relativity, namely, the Friedmann equation. But now our gravitational equations are quite different. Therefore, we must rewrite them as the Friedman equations on the right-hand-side and some effective energy-momentum tensor on the left-hand-side. Of course, such an effective energy-momentum tensor may have nothing in common with the primary one. It appears that in the rather simple non-trivial basic solution we found, the effective energy-momentum tensor contains the cosmological term absent at the beginning. The details we will be presented in the talk.**Keywords:** Scalar-tensor gravity; exact solution; solution-generating symmetry.

Keywords: Invariant Cosmology

Published: 7 August 2021

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