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Spherically symmetric double layers and thin shells in Weyl-Einstein gravity. Theory and examples.

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The role of the exact solutions in gravitational theories is impossible to overestimate. But the intrinsically nonlinear character of gravitational eauations makes solving them a very difficult and problemticc task. This is why the investigations of the hypersurfaces where the matter energy-momentum tensor undergoes some discontinuities are so important. The physically interesting discontinuities are jumps (they can be viewed as an idealization of the shock waves) and thin shells (i.e., δ-function distributions, describing some idealized matter sources including the potential barriers between two different phases during cosmological phase transitions).

The thin shell formalism in General Relativity was elaborated by W.Israel. But, nowadays, the Einstein's theory is no more the ultimate theory of gravitation. The necessity to include into the gravitational action itegral the terms, quadratic (and higher order) in curvature tensor, was foreseen by A.D.Sakharov 50 years ago (induced gravity), and it was confirmed in the series of works by A.A.Starobinsky and Ya.B.Zel'dovich, L.Parker and S.Fulling, A.A.Grib and V.M.Mostepanenko and many others while considering the quantum processes of particale creation in cosmology. The selfconsistent treatment of the black hole evaporation discovered by S.W.Hawking also requires inclusion of such nonliner terms into the action integral. Surely, the first step is to consider the so called quadratic gravity. In this case the gravitational Lagrangian is the most general quadratic form constructed from the Riemann curvature tensor and its convolutions (the Ricci tensor and the curvature scalar), it includes also the Einstein-Hilbert linear term (the curvature scalar) and the cosmological term. It appeared that the quadratic gravity allows the existence of the hypersurfaces more singular than the thin shells. Namely, the double layers (i.e., δ'-distributions) which are completely forbidden in General Relativity. The general thery of such double layers was elaborated quite recently by J.Senovilla et al.

Here we resrict ourselves to investigation of the so called Weyl-Einstein gravity, the specific case of the generic quadratic gravity, when all the quadratic terms are just consituents of the square of the Weyl tensor. This is done partly because the additional symmetry leads to the less restrictive matching conditions (and, hence, deserves separate consideration), and also of the importance of this very combination for the cosmological particle creation processes. For the sake of simplicity (and the physically transparent interpretation) we constructed the theory of the spherically symmetric double layers and thin shells. The applications are the examples of the thin shells without double layers and double layers without thin shells. Also we showed that the matching conditions forbid the formation of the null double layers in Weyl+Einstein gravity.

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