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The generalized LTB solutions in modeling the cosmological black holes

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In spite of the numerous attempts to close the discussion about the influence of cosmological expansion on local gravitationally bounded systems, this question arises in literature again and again and remains still far from its final resolution. Here one of the main problems is the problem of obtaining a physically adequate model of strongly gravitating object immersed in non-static cosmological background. Such objects are usually called 'cosmological'black holes and are of great interest in wide set of cosmological and astrophysical areas.
In this work the set of new exact solutions of the Einstein equations is derived for the flat space that generalizes the known Lemaitre-Tolman-Bondi solution for the case of nonzero pressure. The solutions obtained are pretending to describe the black hole immersed in nonstatic cosmological background and give a possibility to investigate the hot problems concerning the effects of the cosmological expansion in gravitationally bounded systems, the structure formation in the early universe, black hole thermodynamics and other related problems.
It is shown that each of the solutions obtained contains either the Reissner-Nordstrom or the Schwarzschild black hole in the central region of the space.
It is demonstrated that the approach of the mass function use in solving of the Einstein equations allows clear physical interpretation of the resulting solutions, that is of much benefit to any their concrete application.

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