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Nonlinear stability of self-gravitating irrotational Chaplygin fluids in a FLRW geometry.
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Summary: We analyze the global nonlinear stability of FLRW (Friedmann-Lemaître-Robertson-Walker) spacetimes in the presence of an irrotational perfect fluid. We assume that the fluid is governed by the so-called (generalized) Chaplygin equation of state $p = -\frac{A}{\rho^{\alpha}}$ relating the pressure to the mass-energy density, in which $A > 0$ and $\alpha \in (0, 1]$ are constants. We express the Einstein equations in wave gauge as a system of coupled nonlinear wave equations and, after performing a conformal transformation, we analyze the global behavior of solutions toward the future. Under small perturbations, the $(3 + 1)$-spacetime metric, the mass-energy density, and the velocity vector describing the geometry and fluid unknowns remain globally close to a reference FLRW solution. Our analysis provides also the precise asymptotic behavior of the perturbed solutions toward the future.

MSC:
83C55 Macroscopic interaction of the gravitational field with matter (hydrodynamics, etc.)
83F05 Relativistic cosmology
35Q31 Euler equations
35Q76 Einstein equations
76Y05 Quantum hydrodynamics and relativistic hydrodynamics

Keywords:
Einstein-Euler equations; FLRW cosmology; generalized Chaplygin gas; conformal transformation; wave gauge

Full Text: DOI

References:


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