THE STABILITY OF THE IRROTATIONAL EULER-EINSTEIN SYSTEM WITH A POSITIVE COSMOLOGICAL CONSTANT

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Abstract

The irrotational Euler-Einstein system models the evolution of a dynamic spacetime containing a perfect fluid with vanishing vorticity. In this talk, which is a summary of recent joint work with Igor Rodnianski, I will discuss the stability of a family of background cosmological solutions to the irrotational Euler-Einstein system in $1+3$ dimensions with a positive cosmological constant Λ. The background solutions describe an initially uniform quiet fluid of positive energy density evolving in a spacetime undergoing accelerated expansion. Our main result is a proof that under the equation of state $p = c_s^2 \rho$, $0 < c_s^2 < 1/3$, the background solutions are globally future-stable under small irrotational perturbations. In particular, the perturbed spacetimes, which have the topological structure $[0, \infty) \times \mathbb{T}^3$, are future causally geodesically complete. It is of special interest to note that the behavior of the fluid in an exponentially expanding spacetime differs drastically from the case of flat spacetime. More specifically, Christodoulou has recently shown that on the Minkowski space background, irrotational data arbitrarily close to that of an initially quiet uniform fluid can lead to solutions that form shocks. In view of this fact, we remark that the proof of our main result can be used to show the following: exponentially expanding spacetime backgrounds can stabilize irrotational fluids. This work is an extension of recent work by Ringström.