Non linear spherical collapse with relativistic hydrodynamics in a cosmological background

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We are following the works made in [1] and [2], within the framework of numerical relativity. We perform full relativistic numerical simulations with an expanding cosmological background to explore the non linear regime of the spherical collapse with pressure. We use the BSSN formalism of GR, in spherical symmetry, conjointly with the Valencia formulation for the hydrodynamics [3]. The particularity of our approach is the introduction of a non zero equation of state to study the impact of the pressure on the non linear evolution of large scale structures. We point out, among others, that the pressure permits the density contrast δ to stabilize after a damped oscillation phase. The equilibrium value of δ is shown to be function of the equation of state but also of the size of the fluctuation and of the cosmology that is used. Some critical values of the previous parameters determine if the δ grows to infinity or stabilize to a positive (or even non positive) value. This can give a point of comparison with phenomenological approaches that use the Top-Hat approximation of the spherical collapse.

References

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