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Newtonian and Relativistic Cosmologies STEPHEN GREEN, ROBERT WALD, University of Chicago — Cosmological N-body simulations are now being performed using Newtonian gravity on scales larger than the Hubble radius. It is known that a uniformly expanding, homogeneous ball of dust in Newtonian gravity satisfies the Friedmann equations, and also that a correspondence between Newtonian and relativistic dust cosmologies holds in linearized perturbation theory. Nevertheless, it is not obvious that Newtonian gravity can provide a good *global* description of an inhomogeneous cosmology with significant nonlinear dynamical behavior at small scales. We investigate this issue in light of a perturbative framework that we have recently developed. We propose a straightforward dictionary—exact at the linearized level—that maps Newtonian dust cosmologies into GR dust cosmologies, and we use our ordering scheme to determine the degree to which the resulting metric and matter distribution solve Einstein's equation. We then find additional corrections needed to satisfy Einstein's equation to "order 1" at small scales and to "order ϵ" at large scales. We expect that, in realistic Newtonian cosmologies, these additional corrections will be very small; if so, this should provide strong justification for the use of Newtonian simulations to describe GR cosmologies.

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