Covariant density and velocity perturbations of the quasi-Newtonian cosmological model in $f(T)$ gravity

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ABSTRACT

In this work, we investigate classes of shear-free cosmological dust models with irrotational fluid flows within the framework of $f(T)$ gravity. In particular, we use the $1+3$ covariant formalism and we present the covariant linearised evolution and constraint equations. We then derive the integrability conditions describing a consistent evolution of the linearised field equations of quasi-Newtonian universes in the $f(T)$ gravitational theory. Finally, we derive the evolution equations for the density and velocity perturbations of the quasi-Newtonian universe. We explore the behaviour of the matter density contrast for two models of the $f(T)$ theories of gravity, namely the power-law $f(T)$ model where $f(T) = \mu T_0 (T/T_0)^n$ and the more generalized model where $f(T) = T + \mu T_0 (T/T_0)^n$ with and without the application of the so-called quasi-static approximations. Our numerical solutions show that these $f(T)$ models can be suitable alternatives to study the growth of energy density fluctuations, while applying the so-called quasi-static approximation but the results show that this approximation is not applicable here. Moreover, any small deviation from general relativity and any small change in the initial conditions of the perturbations causes huge orders-of-magnitude deviations from limiting general relativistic results, potentially putting constraints on the modified theory.