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Non-linear joint density-velocity evolution in f(R) theories of modified gravity

Recent observations have indicated that all is not well with the standard Lambda-Cold-Dark-Matter (LCDM) model of the Universe. Clues that help constrain the modifications to LCDM are hidden in the large scale structure of the Universe. The fractional density and peculiar velocity are the two main variables that are used to characterize this structure. When the perturbations are small, linear theory works well and the density and velocity divergence are proportional. The proportionality constant, is the 'linear growth factor'which is a sensitive probe of the underlying cosmology and indeed many upcoming observational missions aim to constrain it. However, this linear relation breaks down when the perturbations are of order unity i.e., in the non-linear regime.

The work to be presented, investigates the extension of this relation in the non-linear regime. We will use the spherical top-hat model and examine the evolution of perturbations in the joint density-velocity divergence 'phase-space'. In particular, we will consider the f(R) model of modified gravity with the Hu-Sawicki form as a working example. The equations of motion in f(R) theories are significantly more complicated than the LCDM case and even the simple top-hat model needs to be evolved using a hybrid Lagrangian-Eulerian approach. We find that the results depend sensitively on the ratio of two length scales: the Compton wavelength of the associated scalar field and the width of the top-hat.

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