Title: Study of dark energy and modified gravity and their influence on the cosmological parameters of the universe

Author: Michal Vraštil

Institute: Institute of Physics of the Czech Academy of Sciences

Supervisor: RNDr. Michael Prouza, Ph.D., Institute of Physics of the Czech Academy of Sciences

Abstract: Discovery of the accelerated expansion of the Universe poses a major theoretical puzzle. Although the assumption of a non-zero cosmological constant provides a minimal extension of general relativity that is consistent with observational data, many theories of modified gravity have been suggested as possible alternatives due to serious problems connected with the cosmological constant. Numerical predictions of structure formation for these models in the fully non-linear regime are very expensive and it is difficult, if not impossible, to explore such a huge space of models and parameters using high-resolution N-body simulations. Even in the mildly nonlinear regime, perturbative methods can become extremely complex. We explore whether simplified dynamical approximations, applicable for a certain set of cosmological probes, can be used to investigate models of modified gravity with acceptable accuracy in the latter instance. For the case of chameleon gravity, we found that it is screened away on scales smaller than that of galaxy clusters. On large cosmological scales, we found that approximate methods can be used to explore the region around the baryon acoustic oscillation scale, $k \sim 0.1\ h\mathrm{Mpc}^{-1}$ but not much further.

Keywords: dark energy, modified gravity, N-body simulations, cosmology, approximate methods