

We deal with cosmological perturbation theory in my work. We investigate General Theory of Relativity in Higher Dimensions in the Chapter 1. I mention GHP-formalism and algebraical classification of spacetimes. I use spinors to show that spacetimes of dimension 4 are special. I discuss also Kundt spacetimes, which are interesting for perturbation theory of black holes. I work with perturbations of FLRW ST's in GHP formalism in Chapter 2, which we want to use in Cosmological Inflation. The final part of my thesis is connected with scalar perturbations in  $f(R)$ -cosmologies, that can be used for explaining accelerated expansion in the last 5 billion years. I investigate the Universe at the scales of 150 Mpc, where I could not use the hydrodynamical approach. Thus I work with the generalization of the Landau's mechanical approach. I need quasi-static approximation for getting the potentials  $\Phi$  and  $\Psi$ , since the equations are too complicated for direct integration. I plan to use the result also for numerical simulation of motions of dwarf galaxies in these potentials.