

Solutions of the Einstein field equations in higher dimensions

The goal of the thesis was to search for new solutions and solutions generating techniques so those methods could be used further to enhance research on many-dimensional bran models. The first chapter of the thesis is a review of the current state of knowledge in the field of higher dimensional Einstein equations. Known exact solutions of the equations are discussed, with a special emphasis on spherically symmetric solutions such as a Gross-Perry metric. This chapter presents also the algebraic classification of the higher dimensional metrics developed by Coley, Milson, Pravda and Pravdova.

In the second chapter a new method of solving $(N+n+1)$ -dimensional Einstein equations with $SO(n+1)$ symmetry is presented. The method is divided into two steps. First step is reducing $(N+n+1)$ -dimensional Einstein equations with the cosmological constant to the $(N+1)$ -dimensional Einstein equations with the scalar field of a special form of the potential. Then in the second step, after introducing additional assumptions about the scalar field and the N -dimensional Einstein tensor, further reduction of the equations is performed. This results in a clear procedure of generating new solutions based on finding N -dimensional metric, tensor and three functions of one variable, satisfying some special conditions. The third chapter is devoted to finding new solutions of the Einstein equation using method presented earlier. Some examples of metrics that belongs to Kasner's class or generalized to higher dimensions Kundt's class were obtained. As a main result of the thesis a class of solutions was calculated generalizing Goss-Perry metric to higher dimensions. This class consists of three subclasses with different geometrical properties, some of them are algebraically special. All metrics in the class are asymptotically flat on some section, therefore they can turn out to be useful from the "braneworld" models point of view.

In the fourth chapter the obtained metrics are examined in the context of hidden symmetry transformations which can lead to further new solutions. It occurred that the transformation allows to find metrics with richer structure from a point of view of the Kaluza-Klein theory.