This among the most interesting solutions as einstein’s

This means that there is an amount of redundancy whentreating it in four dimensions, as for instance nothing changes in time. Thesame hold true for the angular coordinates and one can reduce the dimension ofthe problem by mathematically removing one dimension. The dimensional reductionin this paper was developed by the German mathematician Theodore Kaluza and theSwedish physicist Oskar Klein. Reducing one dimension is not as easy as it maysound, and we do not discuss in detail how this works. The action in fourdimensions is replaced by a corresponding action in three dimensions. Solvingthis problem and then performing a decompactification gives the solution infour dimensions. The solution generating techniques described in this thesis areuseful when developing a theory of quantum gravity, the combination of quantummechanics and general relativity.

To construct quantum gravity, it is necesaryto understand the solutions predicted by gravity. Black holes are among themost interesting solutions as Einstein's theories break down into asingularity. To describe black holes in a completely satisfactory way, quantumgravity is needed. Black hole solutions are therefore of great interest, anddimensional reduction is a powerful tool when obtaining these solutions sincehidden symmetries in four dimensions may revealed in three or two dimensions.

Using these symmetries, it is possible to classify black holes and deriveentire families of black holes from one solution. Dimensional reduction is useful, not only to derive solutions of black holes, but also in constructing thetheory of quantum gravity itself. These theories, such as supersymmetry andstring theory, describe a world of ten or eleven dimensions and dimensionalreduction is therefore necessary to describe our four-dimensional world. Indimensional reduction, more terms are added to the action as the number ofdimensions is reduced.

Physical theories that seem different in four dimensionscan be unified in ten or eleven dimensions. On the other hand, the differentaction obtained when four-dimensional Einstein gravity is reduced to three ortwo dimensions reveal hidden symmetries and can be analyzed in the framework ofgroup theory to obtain the four-dimensional solution. The purpose of thisthesis was to show how it is possible to derive the Schwarzschild solution withthe hidden symmetries of a black hole revealed with the dimensional reductionfrom four to three dimensions.

To do this we first present a short introductionto general relativity and group theory and then combine the two to arrive atthe Schwarzschild solution. We succeed in reaching our goal by looking at theaction of the given system, then performing a Kaluza-Klein compactification onthe four-dimensional spacetime to solve the problem in three dimensions. Byperforming a decompactification we then obtain the solution in four dimensions. We also reach beyond Schwarzschild and derive the solution of a charged blackhole, the Reissner-Nordstrom solution. To conclude, in this thesis we firststudy the Schwarzschild solution with Einstein’s theory. Then we perform adimensional reduction to three dimensions to derive the same solution usinggroup theory.

After that we go beyond the Schwarzschild solution and look atthe Reissner-Nordstrom solution as well as other solutions in theSchwarzschild family.