Conclusions

In this thesis we have used two different techniques for the construction of gauged supergravities. The first method is generalized reduction - also called Scherk-Schwarz I reduction - which exploits global symmetries of higher dimensional supergravity theories in order to introduce masses into lower dimensional supergravity theories. The global symmetries used for dimensional reduction generically appear as a gauged symmetry in the lower dimensional theory. The group-manifold equivalent of this mechanism is called Scherk-Schwarz II and deals with diffeomorphisms of the compact group manifold. In this case the masses occur as components of structure constants of a gauge group G in lower dimensions. In chapter 4 we demonstrated the Scherk-Schwarz I mechanism by reducing from eleven down to nine dimensions, by making use of several possible global scaling symmetries. Already at this level various different gaugings could be obtained, among which also non-compact gaugings. Non-compact gaugings in general are very interesting since they are believed to circumvent no-go theorems regarding the existence of de Sitter vacua and supersymmetrized brane-world scenarios. Furthermore, some of the gaugings were only defined at the level of the field equations. A better understanding of these special cases has been obtained recently in [175] in the context of eight-dimensional gauged supergravity.

The second method used in this thesis is the conformal program, which is a tool to construct matter-coupled gauged Poincaré supergravity. Motivated by recent developments like e.g. the brane-world scenario, we performed the conformal program in five dimensions. In chapter 5 the five-dimensional Poincaré algebra was extended to the full superconformal group. By gauging the superconformal group, applying the curvature constraints and introducing auxiliary matter fields, we constructed the minimal representation of the superconformal group, containing the graviton, called the Standard Weyl multiplet. In chapter 6 matter multiplets were introduced: vector-tensor multiplets and hypermultiplets. The transformation rules and corresponding actions were found in the background of the Weyl multipet fields. Finally, in chapter 7 the vector-tensor and hyper action were combined and used as starting point of the gaugefixing procedure. In this procedure we made convenient gauge choices for the symmetries that are not in the Poincaré algebra, and solved for the dependent gaugefields and auxiliary matter fields. The final result of this exercise indeed produced matter-coupled Poincaré supergravity. It furthermore provided an improved understanding of the gauge-fixing procedure, in relation with hyperkähler and quaternionic-Kähler geometry.

Note that we do not claim to have found the most general matter coupled $\mathcal{N} = 2$ Poincaré supergravity in five dimensions. First of all, in view of the applications, we chose to include only vector-tensor and hyper multiplets. Several other representations could have been included as well, like the linear and nonlinear multiplet. Secondly, it can not be excluded that more general gaugings can be found from dimensional reduction; especially if we drop the requirement of an action, several new possibilities may be possible. In all these cases, including our five-dimensional Poincaré action, it is not clear what the higher dimensional origin is, if any.

Compared to the existing formulations by e.g. Ceresole and Dall'Agata [76], or Günaydin and Zagermann [73–75], we have found a generalization by allowing off-diagonal gauge-transformations between the vector and tensor multiplets. This introduces extra terms proportional to the representation matrices $t_{IJ}{}^M$ in the action, transformation rules and most importantly in the scalar potential, that were not found in other literature.

The presence of the extra off-diagonal couplings in the action and transformation rules will probably allow for non-compact gaugings in five dimensions, leading to new classes of solutions, e.g. new domain-walls that can be used for supersymmetric brane-world models. It will be very interesting to see whether these new couplings will lead to new de Sitter vacua and improved realizations of brane-world scenarios. Hopefully, future research will teach us more.