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The Standard Model of particle physics, which describes subatomic phenomena with unprecedented accuracy, is nowadays generally understood to only be an effective low energy limit of a more fundamental theory. The most promising candidates for the underlying theory are superstring theory and its extension, M-theory, which both require the existence of multiple extra dimensions. Usually these dimensions are assumed to be compactified into an extremely small manifold of Planckean size, which would explain their absence in the current experiments. However, recently much greater compactification volumes have been proposed as an alternative solution to the hierarchy problem of the Standard Model. If the extra dimensions are large enough, they could be detected already in the near future colliders either directly or indirectly by the effects of virtual higher dimensional excitations of the Standard Model fields.

In this thesis the effects of large extra dimensions on the low energy phenomenology are studied. It is shown that from the four-dimensional point of view the higher dimensional fields can be decomposed into infinite towers of massive Kaluza–Klein excitations, whose spectra contain information on the size and the topology of the extra dimensions. Including these excitations into the radiative corrections of gauge boson propagators leads to a modification of the conventional logarithmic running of couplings, replacing it by a power law. The gauge couplings then unify at much lower scales than in four-dimensional theories. Various models where the unification actually takes place are discussed, as well as restrictions for building higher dimensional models consistent with the grand unification scenario.

Although the possibility of being able to probe GUT physics already in the LHC is exciting, there are several problems related to the low unification scale that strongly reduce the attractiveness of these models. One is the proton decay, which is no longer suppressed by the enormous value of the GUT scale. Moreover, the grand unification seems less natural, for it has to inserted by hand into the higher dimensional extensions of the Standard Model or the MSSM. The most important defect, however, is that although the extra dimensions are theoretically well motivated, there is no solid reason for the compactification scale to lie right beyond the reach of current experiments, instead of the Planck scale.

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