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Gauge invariance and radiative corrections in an extra dimensional theory

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Abstract content

We discuss the gauge structure of the 4d effective theory arising from a pure 5d Yang-Mills theory compactified on the orbifold S^1/Z_2, reexamined on the basis of the BRST symmetry. If the gauge parameters propagate in the bulk, the excited Kaluza-Klein (KK) modes are gauge fields and the 4D theory is gauge invariant only if the compactification is carried out by using curvatures as fundamental objects. The 4d theory is governed by two types of gauge transformations, one determined by the KK zero modes of the gauge parameters and another by the excited ones. The Dirac's method and the proper solution of the master equation within the field-antifield formalism are employed to show that the theory is subject to first class constraints. A gauge-fixing procedure to quantize the KK modes that is covariant under the first type of gauge transformations is shown and the ghost sector induced by the gauge-fixing functions is presented. The effective quantum Lagrangian linking the light and heavy physics is shown and its predictive character stressed. If the gauge parameters are confined to the 3-brane, the known result in the literature is reproduced with some minor variants, although it is emphasized that the excited KK modes are not gauge fields, but matter fields transforming under the adjoint representation of $SU_4(N)$. In this case, the Dirac's method leads to both first and second class constraints. A calculation of the one-loop contributions of the excited KK modes of the $SU_L(2)$ gauge group on the off-shell $WW\gamma$ and WWZ vertices is exhibited. Such contributions are free of ultraviolet divergences and well-behaved at high energies. For a size of the fifth dimension of $R^{-1} \sim 1TeV$, the one-loop contribution of the KK modes to these vertices is about one order of magnitude lower than the corresponding standard model radiative correction.

Summary

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