Reduction of couplings: from Finiteness to Fuzzy extra dimensions

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Abstract

Finite Unified Theories (FUTs) are N=1 supersymmetric Grand Unified Theories, which can be made all-loop finite, both in the dimensionless (gauge and Yukawa couplings) and dimensionful (soft supersymmetry breaking terms) sectors. This remarkable property, based on the reduction of couplings at the quantum level, provides a drastic reduction in the number of free parameters, which in turn leads to an accurate prediction of the top quark mass in the dimensionless sector, and predictions for the Higgs boson mass and the supersymmetric spectrum in the dimensionful sector. Here we examine the predictions of two such FUTs. Next we consider gauge theories defined in higher dimensions, where the extra dimensions form a fuzzy space (a finite matrix manifold). We emphasize some striking features emerging such as (i) the appearance of non-abelian gauge theories in four dimensions starting from an abelian gauge theory in higher dimensions, (ii) the fact that the spontaneous symmetry breaking of the theory takes place entirely in the extra dimensions and (iii) the renormalizability of the theory both in higher as well as in four dimensions. This scheme represents so far an excellent example in which classical reduction of couplings takes place. However since it leads to renormalizable theories, has the ingredients to become a framework for quantum reduction too.