PHENOMENOLOGICAL STUDIES IN SUPERSYMMETRIC AND HIGHER DIMENSIONAL EXTENSIONS TO THE STANDARD MODEL OF PARTICLE PHYSICS

Abstract

by

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This thesis contains four research topics in the phenomenology of physics beyond the Standard Model (SM), specifically focusing on the mass spectra of the Minimal Supersymmetric Standard Model (MSSM) and extra dimensional TeV^{-1} scale compactification scenarios with gauge, matter and Higgs Kaluza-Klein (KK) excitations of the SM fields. In the context of the MSSM, an overview of the muon anomalous magnetic moment, a_μ, with the latest SM theoretical and experimental data is provided. A general analysis of the MSSM contributions to the muon anomalous magnetic moment is given and general upper bounds on the masses of the four lightest sparticles are derived as a function of the deviation from the expected SM theoretical value. Also in the context of the MSSM, regions in the parameter space predicting an electrically charged lightest supersymmetric particle (LSP) are typically discarded based on thermal relic abundance estimates combined with direct searches for anomalously heavy water. Independent of the cosmological relic abundance, a novel method using cosmic ray production from the all-particle incident cosmic ray flux is shown to provide a nontrivial constraint on the strongly interacting sector of the MSSM when the LSP is charged. This methodology of cosmic ray production of weak-scale massive charged particles is extended and applied to

"universal extra dimensions", orbifold extra dimensional models in which all the SM fields have KK excitations, the lightest of which is stable. In the final section of the thesis both supersymmetry and extra dimensions are applied toward constructing a model which can accommodate a late-time variation in the fine structure constant (based on reports of such a phenomenon in the literature), while simultaneously relating this variation to the onset of dominance of an effective cosmological constant occurring in the same epoch. Using the shape, rather than the radial moduli of the compactification manifold, it is possible to radiatively induce a change in the fine-structure constant from the KK modes of the SM sector confined to a "thick" brane.