

Swarup Kumar Majee

Research Summary:

My current research interest lies on the topic of Universal Extra Dimension (UED), Supersymmetry Higgs search and Supersymmetric Grand Unified Theory in high energy particle physics. During 2006-07, I have worked on the following topics –

(1) Power law scaling in Universal Extra Dimension scenarios

Collaborators: Gautam Bhattacharyya, Anindya Datta, Amitava Raychaudhuri

We study the power law running of gauge, Yukawa and quartic scalar couplings in the universal extra dimension scenario where the extra dimension is accessed by all the standard model fields. After compactifying on an S_1/Z_2 orbifold, we compute one-loop contributions of the relevant Kaluza-Klein (KK) towers to the above couplings up to a cutoff scale Λ . Beyond the scale of inverse radius, once the KK states are excited, these couplings exhibit power law dependence on Λ . As a result of faster running, the gauge couplings tend to unify at a relatively low scale, and we choose our cutoff also around that scale. For example, for a radius $R \sim 1TeV^{-1}$, the cutoff is around 30 TeV. We then examine the consequences of power law running on the triviality and vacuum stability bounds on the Higgs mass. We also comment that the supersymmetric extension of the scenario requires R^{-1} to be larger than $\sim 10^{10}$ GeV in order that the gauge couplings remain perturbative up to the scale where they tend to unify.

(2) Low Intermediate Scales for Leptogenesis in Supersymmetric SO(10) Grand Unified Theories

Collaborators: Mina K. Parida, Amitava Raychaudhuri, Utpal Sarkar

A low intermediate scale within minimal supersymmetric SO(10) GUTs is a desirable feature to accommodate leptogenesis. We explore this possibility in models where the intermediate gauge symmetry breaks spontaneously by (a) doublet Higgs scalars and also (b) by triplets. In both scenarios gauge coupling unification requires the scale of left-right symmetry breaking (M_R) to be close to the unification scale. This will entail unnaturally small neutrino Yukawa couplings to avoid the gravitino problem and allow successful leptogenesis. We point out that any one of three options – threshold corrections due to the mass spectrum near the unification scale, gravity induced non-renormalizable operators near the Planck scale, or presence of additional light Higgs multiplets – can permit unification along with much lower values of M_R as required for leptogenesis. In the triplet model, independent of these corrections, we find a lower bound on the intermediate scale, $M_R > 10^9$ GeV, arising from the requirement that the theory must remain perturbative at least upto the GUT scale. We show that in the doublet model M_R can even be in the TeV region which, apart from permitting resonant leptogenesis, can be tested at LHC and ILC.

(3) **Extra-dimensional relaxation of the upper limit of the lightest supersymmetric neutral Higgs mass**

Collaborators: Gautam Bhattacharyya, Amitava Raychaudhuri

The upper limit on the mass of the lightest CP-even neutral Higgs in a supersymmetric theory with two Higgs doublets is around 135 GeV. We demonstrate that this upper limit may be sizably relaxed, even by few tens of GeV, if supersymmetry is embedded in extra dimensions. We calculate, using the effective potential technique, the radiative corrections to the lightest Higgs mass induced by the Kaluza-Klein towers of quarks and squarks with one and two compactified directions.

Publications:

1. Gautam Bhattacharyya, Anindya Datta, Swarup Kumar Majee, Amitava Raychaudhuri, *Power law scaling in universal extra dimension scenarios*, Nuclear Physics B **760**, 117-127, (2006)
2. Swarup Kumar Majee, M. K. Parida, Amitava Raychaudhuri, Utpal Sarkar, *Low intermediate scales for leptogenesis in supersymmetric SO(10) grand unified theories*, Phys. Rev. D **75**, 075003, (2007)
3. M.K. Parida et al *Working group report: Flavor physics and model building*, Pramana **67**, 849-860, (2006).

Preprints:

1. Gautam Bhattacharyya, Swarup Kumar Majee, Amitava Raychaudhuri *Extra-dimensional relaxation of the upper limit of the lightest supersymmetric neutral higgs*, (in preparation)

Conference/Workshops Attended:

1. *Workshop on LHC Physics*, TIFR, India, September, 2006,
2. *17th DAE-BRNS Symposium on HEP*, IIT KHARAGPUR, India, December, 2006.,
3. *Topical Meeting on Physics at the LHC*, HRI, India, December, 2006,
4. *21st International Workshop on Weak Interactions and Neutrinos (WIN07)*, SINP, Kolkata, India, January, 2007.
5. *International Workshop on Theoretical High Energy Physics (IWTHEP)*, IIT Roorkee, India, March, 2007.

Invited Lectures/Seminars:

1. *Power law scaling in the UED model*, 17th DAE-BRNS Symposium on HEP, IIT KHARAGPUR, India, December 2006.
2. *Power law scaling in the UED model*, 21st International Workshop on Weak Interactions and Neutrinos (WIN07), SINP, Kolkata, January 2007.

Other Activities:

1. Tutor on the the course Relativistic Quantum Mechanics and particle physics in the 1st phase of INO Training School, April, 2006.
2. Pheno lunch review talk (a) Dark Matter in Universal Extra Dimension Models: γ_{KK} Vs. $\nu_{R, KK}$ [hep-ph/0604154], May, 2006
(b) Solving problems of 4D minimal SO(10) model in a warped extra dimension [hep-ph/0702048], February, 2007