

International Workshop on Grand Unified Theories: Current Status and Future Prospects

Monday 17 December 2007 - Wednesday 19 December 2007

Ritsumeikan University



Book of Abstracts

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Welcome to Ritsumeikan University

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Scope of Workshop and Organization questions

Author: Takeshi Fukuyama¹

¹ *Ritsumeikan University*

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Does the extra dimension rescue the SO(10) GUT?

Author: Takeshi Fukuyama¹

¹ *Ritsumeikan University*

Plenary Talks / 58

Review of phenomenological models

Author: Koichi Matsuda¹

¹ *Tsinghua University*

Plenary Talks / 59

Discrete Gauge Symmetries and Proton Stability in grand unified theories

Author: Rabindra. N. Mohapatra¹

¹ *University of Maryland*

We discuss the results of a search for anomaly free Abelian Z_N discrete symmetries that lead to automatic R-parity conservation and prevents dangerous higher-dimensional proton decay operators in simple extensions of the minimal supersymmetric extension of the standard model (MSSM) based on the left-right symmetric group, the Pati-Salam group and SO(10). We require that the superpotential for the models have enough structures to be able to give correct symmetry breaking to MSSM and potentially realistic fermion masses. We find viable models in each of the extensions and for all the cases, anomaly freedom of the discrete symmetry restricts the number of generations.

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B-aniti-B mixing and lepton flavor violation in supersymmetric grand unified models

Author: Yukihiro Mimura¹

¹ *Texas A&M University*

We study B-anti-B mixing in grand unified SO(10), SU(5) models where the mixings among the second and third generation squarks arise due to the existence of flavor violating sources in the Dirac and Majorana couplings which are responsible for neutrino mixings. We find that when the branching ratio of $\tau \rightarrow \mu \gamma$ decay is enhanced to be around the current experimental bound, B_s -anti-B mixing may also contain large contribution from supersymmetry in the SO(10) boundary condition. We also study the constraint arising from the recently observed D-anti-D mixing. In the left-right symmetric unified models, the supersymmetric contributions in the mixing amplitudes of D-anti-D, K-anti-K and B-anti-B are all correlated. We compare the constraint from the D-D mixing with the K-anti-K mixing and find that the D-anti-D mixing constrains the maximal supersymmetric contribution to the B_s -anti- B_s mixing amplitude. The maximal supersymmetric contribution can allow a large CP phase of B_s -anti- B_s mixing which can be tested by the ongoing measurement of the phase of $B_s \rightarrow J/\psi \phi$ decay.

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Differentiating Neutrino Models on the Basis of the Reactor Angle and Lepton Flavor Violation

Author: Carl. H. Albright¹

¹ Northern Illinois University and Fermilab

An earlier survey of viable neutrino mass and mixing models revealed a broad spectrum of predicted values for $\sin^2(\theta_{13})$ ranging from the present upper bound of 0.04 accessible to the next round of reactor neutrino experiments down to values less than 0.001 requiring a neutrino factory for observation. Here we single out models with similar θ_{13} predictions and show that the viability of each type can be further differentiated according to their predictions for the l_j to l_i lepton flavor-violating branching ratios for various of the CMSSM parameters. This study supplements previous results obtained on the θ_{13} - lepton flavor violation connection which involved restrictions on the class of SUSY GUT seesaw models considered.

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Nucleon sigma term from lattice QCD

Author: Tetsuya Onogi¹

¹ YITP, Kyoto University

There has been renewed interest in the nucleon sigma term - the scalar form factor of the nucleon at zero recoil - since it determines the dark matter reaction rate with nucleon through the t-channel Higgs boson exchange. Despite its importance and its long history of theoretical studies, there are still substantial uncertainties. We present our recent studies of the nucleon sigma term based on the JLQCD project of $N_f=2$ unquenched lattice QCD simulation with dynamical overlap fermion.

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”TBA”

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Proton decay in SO(10) with stabilized doublet-triplet splitting

Author: Kaladi. S. Babu¹

¹ *Oklahoma State University*

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New Physics in Colliders

Author: Nobuchika Okada¹

¹ *KEK*

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Proton Decay and Flavor Violating Thresholds in SO(10) Models

Author: Yukihiro Mimura¹

¹ *Texas A&M University*

Discovery of neutrino mass has put the spotlight on supersymmetric SO(10) as a natural candidate for grand unification of forces and matter. However, the suppression of proton decay is a major problem in any supersymmetric grand unified models. In this paper we show how to alleviate this problem by simple threshold effect which raises the colored Higgsino masses and the grand unification scale to $\sim 10^{17}$ GeV. There exist only four types of fields arising from different SO(10) representations which can generate this kind of threshold effects. Some of these fields also generate a sizable flavor violation in the quark sector compared to the lepton sector. The b - τ unification can work in these types of models even for intermediate values of $\tan\beta$.

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Can the extra dimension rescue the SO(10) GUT?

Author: Takeshi Fukuyama¹

¹ *Ritsumeikan University*

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String compactification and unification of forces

Author: Jihn. E. Kim¹

¹ *Seoul National University*

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Three family GUT-like models from heterotic string

Author: Kei-Jiro Takahash¹

¹ *Kyoto University*

We recently developed string compactification on non-factorizable orbifold. Especially in E8xE8 Heterotic string, we obtain SU(5) and SO(10) GUT-like models with simple assumptions. These models have simple spectra including three generations of matter and messenger-like sectors.

Plenary Talks / 70

CP and SUSY breaking and E6 GUT

Author: Nobuhiro Maekawa¹

¹ *Nagoya University*

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Scalar non-degeneracy and flavor unification

Author: Kentaro Kojima¹

¹ *Kyusyu University*

A general consequence of GUT is unification of flavor. It is shown that the non-degeneracy of scalar superparticles provides a direct imprint of flavor structure in high-energy fundamental theory.

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”TBA”

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Gauge-Higgs Unification

Author: Yutaka Hosotani¹

¹ *Osaka University*

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Towards a Realistic Grand Gauge-Higgs Unification

Author: Nobuhito Maru¹

¹ *Kobe University*

We investigate a 5D SU(6) grand gauge-Higgs unification model compactified on an orbifold S^1/Z_2 . Ordinary quarks and leptons, together with right-handed neutrinos, are just accommodated into a minimal set of representations of the gauge group, without introducing any exotic states. The proton decay turns out to be forbidden at least at the tree level. We also find a correct electroweak symmetry breaking $SU(2)_L \times U(1)_Y \rightarrow U(1)_{em}$ is easily realized by introducing suitable number of adjoint fermions.

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Search for a realistic orbifold grand unification

Author: Yoshiharu Kawamura¹

¹ *Shinshu University*

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Higgsless breaking of Grand Unification

Author: Toshifumi Yamashita¹

¹ *Osaka University*

We consider a possibility of higgsless breaking of the grand unified symmetry. In contrast with the orbifold breaking, the rank can be reduced in this breaking. We apply this breaking to a 5D SO(10) model.

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Probing Unification Scale Physics at TeV-scale Collider Experiments

Author: Hitoshi Murayama¹

¹ *University of California, Berkeley and Institute for the Physics and Mathematics of the Universe, University of Tokyo*

Grand Unification and seesaw mechanism of neutrino mass are physics at extremely high energies, which may not allow for direct experimental tests. Here I will discuss how we may obtain information about such extreme high energy physics based on TeV-scale collider data, such as LHC and ILC.

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SUSY and Cosmology – inflation, gravitino, and axion

Author: Masahiro Kawasaki¹

¹ *ICRR, University of Tokyo*

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”TBA”

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”TBA”

Author: Qaisar Shafi¹

¹ *Bartol Research Institute and Delaware University*

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discussion

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A three Site Higgsless Model

Author: Masafumi Kurachi¹

¹ *YITP, Kyoto University*

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Building a model by coset space dimensional reduction using 10 dimensional coset spaces

Author: Takaaki Nomura¹

¹ *Saitama University*

Most of the free parameters in the SM are contained in the Higgs potential terms and the Yukawa coupling terms, i.e. the Higgs associated terms. This fact suggests that if the origin of the Higgs particle results in a more fundamental model, this model would be described by fewer free parameters. One of the candidates of the model that gives origin of the Higgs particles is a gauge-Higgs unification model. Among these ideas we are interested in gauge-Higgs unification models based on the coset space dimensional reduction (CSDR) scheme. In CSDR, we assume the fundamental model is gauge theory in higher dimensional space-time that has extra dimensions of coset space structure. We investigate models based on CSDR scheme using 10 dimensional coset spaces.

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How to Evade a NO-GO Theorem in Flavor Symmetries

Author: Yoshio Koide¹

¹ *Osaka University*

We may expect that an approach based on symmetries will be a powerful instrument for investigating the origin of the flavors. However, when we want to introduce a symmetry (discrete one, U(1), and any others) into our mass matrix model, we always encounter an obstacle, the so-called No-Go theorem in flavor symmetries (YK, Phys.Rev. D71 (2005) 016010). In the present talk, I would like to talk about how to evade this No-Go theorem in order to build a realistic mass matrix model. I will suggest three ways to evade the theorem.

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Unparticle Dark Matter

Author: Tatsuru Kikuchi¹

¹ *KEK*

Once a parity is introduced in unparticle physics, under which unparticle provided in a hidden conformal sector is odd while all Standard Model particles are even, unparticle can be a suitable candidate for the cold dark matter (CDM) in the present universe through its coupling to the Standard Model Higgs doublet. We find that for Higgs boson mass in the range, $114.4 \text{ GeV} < m_h < 250 \text{ GeV}$, the relic abundance of unparticle with mass $50 \text{ GeV} < m_U < 80 \text{ GeV}$ can be consistent with the currently observed CDM density. In this scenario, Higgs boson with mass $m_h < 160 \text{ GeV}$ dominantly decays into a pair of unparticles and such an invisible Higgs boson may be discovered in future collider experiments.

Ref.: e-Print: arXiv:0711.1506 [hep-ph]

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Inflation and Unification

Author: Qaisar Shafi¹

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Gauge unification in 5-D SU(5) model with orbifold breaking of GUT symmetry

Author: Biswajoy Brahmachari¹

¹ *Vidyasagae Evening College*

We consider a 5-dimensional SU(5) model wherein the symmetry is broken to the 4-dimensional Standard Model by compactification of the 5th dimension on an $S^1/(Z_2 \times Z'_2)$ orbifold. We identify the members of all SU(5) representations upto 75 which have zero modes. We examine how these light scalars affect gauge coupling unification assuming a single intermediate scale and present several acceptable solutions. The 5-D compactification scale coincides with the unification scale of gauge couplings and is determined via this renormalization group analysis. When SO(10) is considered as the GUT group there are only two solutions, so long as a few low dimensional scalar multiplets upto 126 are included.

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Gauge unification in 5-D SU(5) model with orbifold breaking of GUT symmetry

Author: Biswajoy Brahmachari¹

¹ *Vidyasagae Evening College*

We consider a 5-dimensional SU(5) model wherein the symmetry is broken to the 4-dimensional Standard Model by compactification of the 5th dimension on an $S^1/(Z_2 \times Z'_2)$ orbifold. We identify the members of all SU(5) representations upto 75 which have zero modes. We examine how these light scalars affect gauge coupling unification assuming a single intermediate scale and present several acceptable solutions. The 5-D compactification scale coincides with the unification scale of gauge couplings and is determined via this renormalization group analysis. When SO(10) is considered as the GUT group there are only two solutions, so long as a few low dimensional scalar multiplets upto 126 are included.

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Family Symmetry and GUTs

Author: Steve. F. King¹

¹ *University of Southampton*

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New Physics in Colliders

Author: Nobuchika Okada¹

¹ *KEK*