5th Workshop on Flavor Symmetries and consequences in accelerators and cosmology: FLASY 2015

Monday 29 June 2015 - Thursday 02 July 2015

Manzanillo, Colima

Book of Abstracts

Contents

0

Predictions for the Leptonic Dirac CP Violation Phase

Mr. GIRARDI, Ivan[1] ; Prof. PETCOV, Serguey[1] ; Mr. TITOV, Arsenii[1]

[1] *SISSA/INFN*

Corresponding Author(s): igirardi@sissa.it

Using the fact that the neutrino mixing matrix $U = U_e^\dagger U_\nu$, where U_e and U_ν result from the diagonalisation of the charged lepton and neutrino mass matrices, we analyse the predictions based on the sum rules which the Dirac phase δ present in U satisfies when U_ν has a form dictated by, or associated with, discrete symmetries and U_e has a "minimal" form (in terms of angles and phases it contains) that can provide the requisite corrections to U_ν, so that the reactor, atmospheric and solar neutrino mixing angles θ_{13}, θ_{23} and θ_{12} have values compatible with the current data. We construct the likelihood function for $\cos\delta$, using i) the latest results of the global fit analysis of neutrino oscillation experiments and ii) the prospective sensitivities on the Pontecorvo, Maki, Nakagawa, Sakata (PMNS) mixing angles. Our results, in particular, show that the experimental measurement of the Dirac phase in the PMNS mixing matrix together with an improvement of the precision on the mixing angles can provide unique information about the possible symmetry in the lepton sector.

1

P, C, and T: conservation and violation on the kinematical level

Prof. DVOEGLAZOV, Valeriy[1]

[1] *Universidad de Zacatecas*

Corresponding Author(s): vdvoeglazov@yahoo.com.mx

We study the dicrete symmetries (P, C, T) on the kinematical level. We found problems in construction of the neutral particles in the (1,0)+(0,1) and (1/2,1/2) representations of the Lorentz Group. As well known the photon has the quantum numbers 1ˆ-, so it is quite relevant to the relativity. It appears that the answers are connected with the helicity basis properties, and commutations /anticommutations corresponding operators, and Cˆ2, Pˆ2, (CP)ˆ2 properties. The previous paper results are clarified. The application to the (1/2,0)+(0,1/2) representation and the flavours is straightforward.

2

Radiative Corrections and Degenerate Neutrinos

Mr. HOLLIK, Wolfgang G.[1]

[1] *Karlsruhe Institute of Technology*

Corresponding Author(s): hollik@kit.edu

Degenerate neutrino masses need a special flavor symmetry at work for the tree-level configuration. Majorana neutrinos require SO(3). We show that the presence of threshold corrections to neutrino masses at the electroweak scale may destroy the degenerate pattern and generate the observed neutrino mixing.
Compared to the case with different Majorana CP-phases for each mass eigenstate, the exact degenerate scenario has no mixing at tree-level. We compare both situations with a special focus on the exact degenerate pattern which gets altered by virtue of supersymmmetric threshold corrections in a seesaw-extended MSSM. Non-minimal flavor violation in the soft breaking terms allows to produce the desired mixing and deviations from equal masses. Such a description may hint to flavor symmetries in SUSY breaking. A solution of the flavor puzzle is then connected to a solution how to break supersymmetry.

3

Towards a complete $A_4 \times SU(5)$ SUSY GUT

DE MEDEIROS VARZIELAS, Ivo[1] ; BJÖRKEROTH, Fredrik[1] ; DE ANDA, Francisco J.[2] ; KING, Stephen[1]

[1] *University of Southampton*

[2] *Universidad de Guadalajara*

Corresponding Author(s): panchjosedea@hotmail.com

We propose a renormalisable model based on A_4 family symmetry with an $SU(5)$ grand unified theory (GUT) which leads to the minimal supersymmetric standard model (MSSM) with a two right-handed neutrino seesaw mechanism. Discrete \$\mathbb{Z}9\times \mathbb{Z}_6symmetryprovidesthefermionm
Barrmechanism.WediscussboththeA_4andSU(5)symmetrybreakingsectors, includingdoublet−
tripletsplittingandtheoriginofthe\muterm.Themodelprovidesanexcellentfit(betterthanonesigma)toallquarkar
8.7^{\circ},\theta^l_{12}\approx 34^{\circ},\theta^l_{23}\approx 46^{\circ}andanoscillationphase\delta^l\app
-87^{\circ}\$.

4

Flavor changing neutral scalar interactions in Two Higgs Doublet Model

Author(s): Dr. MONTES DE OCA YEMHA, jose halim[1]
Co-author(s): Dr. GAITAN, Ricardo [2] ; Dr. GARCES GARCIA, Estela Alejandra [3] ; Dr. MARTINEZ, Roberto [4]

[1] *unam*

[2] *FES-Cuautitlan UNAM*

[3] *Fes Cuautitlan UNAM*

[4] *Universidad Nacional de Colombia*

Corresponding Author(s): josehalim@gmail.com

Models beyond the Standard Model with extra scalars are highly motivated by the recent discovery of scalar Higgs boson. The Two Higgs Doublet Model Type III considers the most general case for the scalar potential and Yukawa interactions. We are interested in flavor changing interactions between neutral Higgs bosons and fermions which arises from Yukawa couplings. In particular we study the decay $t \to c\gamma$ at one loop level where neutral flavor changing is generated by top-charm-Higgs coupling giving by the Yukawa term. We obtain $Br(t \to c\gamma)$ of the order of 10^{-6} for $\tan\beta = 2.5$ and general neutral Higgs mixing parameters $1.16 \leq \alpha_1 \leq 1.5$, $-0.48 \leq \alpha_2 \leq -0.1$.

5

Standard Model Fermion Masses and Mixing Angles generated in a 3HDM

Ms. SOLAGUREN-BEASCOA NEGRE, Ana[1] ; Prof. IBARRA, Alejandro[2]

[1] *Technische Universität München - Max Planck Institut für Physik*

[2] *Technische Universität München*

Corresponding Author(s): asolaguren33@hotmail.com

We present a framework to generate the mass hierarchies and mixing angles of the fermionic sector of the Standard Model with two extra Higgs doublets and one right-handed neutrino. The masses of the first and second generation are generated by small quantum effects, explaining the hierarchy with the third generation. The model also generates a natural hierarchy between the first and second generation after the assumption that the Yukawa couplings are of rank 1. All the quark and lepton mixing matrices can also be generated by quantum effects, reproducing the hierarchies of the experimental values. The parameters generated radiatively depend logarithmically on the heavy Higgs masses, therefore this framework can be reconciled with the stringent limits on flavor violation by postulating a sufficiently large new physics scale.

6

Results from the OPERA experiment at the CNGS beam

Author(s): Dr. ISHIGURO, Katsumi[1]
Co-author(s): Prof. KODAMA, Koichi [2]

[1] *Nagoya University*

[2] *Aichi University of Education,*

Corresponding Author(s): laura.patrizii@bo.infn.it

The OPERA experiment at the Gran Sasso underground laboratory has been designed to study the nu_mu -> nu_tau oscillation in appearance mode in the CNGS neutrino beam. Four nu_tau candidate events have been confirmed so far, using a sub-sample of data from the 2008-2012 runs. Given the number of analysed events and the low background, nu_mu -> nu_tau oscillations have been established with a significance of 4.2 sigma. In the talk we will present results based on an increased sample of scanned emulsion target units (bricks). The nu_tau data analysis will be updated and discussed, with emphasis on the background constraints obtained by using dedicated data-driven control samples. The analysis of the present tau neutrino and electron neutrino samples in the framework of the 3+1 sterile model will be presented. Finally the analysis of the muon charge ratio in the cosmic ray sample will be covered

7

The double mass hierarchy pattern: simultaneously understanding quark and lepton mixing

Mr. SALDAÑA SALAZAR, Ulises Jesús[1] ; Mr. HOLLIK, Wolfgang G.[2]

[1] *Instituto de Fisica (UNAM)*

[2] *Karlsruhe Institute of Technology*

Corresponding Author(s): ulisesjesus@fisica.unam.mx

The charged fermion masses of the three generations exhibit the two strong hierarchies m3 » m2 » m1. We assume that also neutrino masses satisfy a normal ordering and derive the consequences of the hierarchical spectra on the fermionic mixing patterns. The quark and lepton mixing matrices are built in a general framework with their matrix elements expressed in terms of the corresponding four fermion mass ratios of each sector. In this framework, we show that the resulting mixing matrices are consistent with data for both quarks and leptons, despite the large leptonic mixing angles. The minimal assumption we take is the one of hierarchical masses and minimal flavour symmetry breaking that strongly follows from phenomenology. No special structure of the mass matrices has to be assumed that cannot be motivated by this minimal assumption. This analysis allows us to predict the neutrino mass spectrum and set the mass of the lightest neutrino well below 0.01 eV. The method also gives the one sigma allowed ranges for the leptonic mixing matrix elements. Contrary to the common expectation, leptonic mixing angles are found to be determined solely by the four leptonic mass ratios without any relation to symmetry considerations as commonly used in flavor model building. Still, our formulae can be used to build up a flavor model that predicts the observed hierarchies in the masses - the mixing follows then from the procedure which is developed in this work.

8

Adjoint SU(5) GUT model with T7 flavor symmetry

Author(s): Dr. CÁRCAMO HERNÁNDEZ, Antonio Enrique[1] ; Dr. ARBELAÉZ RODRÍGUEZ, Carolina[1]
Co-author(s): Prof. KOVALENKO, Sergey [1] ; Prof. SCHMIDT ANDRADE, Iván Eugenio [1]

[1] *Universidad Técnica Federico Santa María*

Corresponding Author(s): antonio.carcamo@usm.cl

We propose an adjoint SU(5)GUT model with a T7 family symmetry, that successfully describes the prevailing SM fermion mass and mixing pattern. The light active neutrino masses can be

generated by type I and type III see saw mechanisms. The model predictions for both quark and lepton sectors are in a very good agreement with the experimental data. The model predicts an effective Majorana neutrino mass, relevant for neutrinoless double beta decay, with values 4 and 50 meV for the normal and the inverted neutrino spectrum, respectively. The model also features CP conservation in neutrino oscillations. In addition we construct some of the simplest standard model extensions of fields, which sucessfully lead to SU(5) gauge coupling unification and are consistent with the smallness of neutrino masses and proton decay limits. We find limits for the seesaw scale in agreement with phenomenological constraints such as cold dark matter. In the set of configurations analyzed, some of the fields, being coloured, could give rise to potential signals at the LHC.

9

Flavored surprises at the LHC

VICENTE, Avelino[1]

[1] *Université de Liège*

Corresponding Author(s): avelino.vicente@ulg.ac.be

In addition to the discovery of the long-awaited Higgs boson, the LHC Run I brought us several surprises in flavor physics. Among them, two have attracted a great deal of attention: a hint for Higgs lepton flavor violating decays at CMS and a collection of anomalies in b to s transitions at LHCb, including an intriguing hint for lepton universality violation. In this talk we will discuss some models that address these two 'flavored surprises' and show how they may point to a link between flavor physics and other fundamental problems such as the dark matter of the universe.

10

Flavor Unified GUTs, Maximal CP Violation, and delta(PMNS)=+-delta(CKM)

Corresponding Author(s): jihnekim@gmail.com

The new form for the Jarlskog determinant J=Im(V31 V22 V33) is derived after making Det(V) real, and the maximality of the weak CP violation is proved. A string derivation of family unified model SU(7)xU(1) is suggested, and it is speculated delta(PMNS)=+-delta(CKM)

11

Discrete Flavor Symmetries and Origin of CP Violation

Corresponding Author(s): muchunc@uci.edu

I will discuss the origin of CP violation in settings with a discrete (flavor) symmetry. In particular, we show that certain discrete symmetries clash with CP in the sense that, in generic settings with such symmetries, one cannot consistently define a proper CP transformation. For such discrete symmetries, CP violation can be purely group theoretical, leading to physical effects such as particle decay asymmetry.

12

Highlights of three years of LHC physics

Corresponding Author(s): joao.varela@cern.ch

We present a selection of highlights of the LHC physics in the first three years of operation. Order of 1000 publications have been produced by the LHC collaborations in this period. No attempt will be made of a comprehensive summary. Instead the presentation puts emphasis on measurements of the SM Higgs boson, top quark and vector bosons by ATLAS and CMS. Flavor physics measurements performed mainly by LHCb are not covered, neither measurements with ion beams by ALICE, ATLAS and CMS. Searches for physics beyond the SM are briefly mentioned. Prospects for the LHC Run2 and beyond conclude the presentation.

13

Unified Models of Neutrinos, Flavour and CP violation

In this talk we shall give an overview of unified models of quark and lepton (including especially neutrino) masses and mixing based on discrete CP and family symmetries. Various different approaches to model building will be described, denoted as direct, semi-direct and indirect. The minimal predictive seesaw model is introduced and embedded into a fairly complete SU(5) SUSY GUT with A4 symmetry. An A to Z of Flavour with Pati-Salam will also be discussed. Leptogenesis and SUSY flavour predictions of such models are described as well as their possible string theory origins.

14

Finite Unified Theories and discrete symmetries: a successful example of reduction of couplings

Corresponding Author(s): myriam@fisica.unam.mx

We apply the method of reduction of couplings in a Finite Unified Theory (FUT). The method consists on searching for renormalization group invariant relations among couplings/parameters of a renormalizable theory holding to all orders in perturbation theory. It has a remarkable predictive power since, at the unification scale, it leads to relations between gauge and Yukawa couplings in the dimensionless sectors and relations involving the trilinear terms and the Yukawa couplings, as well as a sum rule among the scalar masses and the unified gaugino mass in the soft breaking sector. The reduced solution usually imples the existence of discrete symmetries in the Lagrangian. We show the predictions of this model.

15

LFV Higgs decays in a Flavor extended MSSM

Corresponding Author(s): melina.gomez@udlap.mx

16

Lepton flavor mixing and CP symmetry

Corresponding Author(s): dinggj@ustc.edu.cn

The strategy of constraining the lepton flavor mixing from remnant CP symmetry is investigated in a rather general way. The neutrino mass matrix generally admits four remnant CP transformations which can be derived from the measured lepton mixing matrix in the charged lepton diagonal basis. Conversely, the lepton mixing matrix can be reconstructed from the postulated remnant CP transformations. All mixing angles and CP violating phases can be completely determined by the full set of remnant CP transformations or three of them. When one or two remnant CP transformations are preserved, the resulting lepton mixing matrix would depend on three real parameters or one real parameter respectively in addition to the parameters characterizing the remnant CP, and the concrete form of the mixing matrix is presented. The phenomenological predictions for the mixing parameters are discussed.

17

Gauged Flavor Symmetries

In gauging the Standard Model flavor group, anomaly cancellation requires adding fermions. Remarkably their mass is inversely related to the known fermion masses, as in the well known neutrino see-saw. In this case all flavor violating effects turn out to be controlled roughly by the Standard Model Yukawa, suppressing transitions for the light generations. Due to the inverted hierarchy the scale of new gauge flavor bosons could be as low as the electroweak scale. The mechanism of flavor protection potentially provides an alternative to Minimal Flavor Violation, with flavor violating effects suppressed by hierarchy of scales rather than couplings.

18

The shape of (new) physics in B decays

Corresponding Author(s): jmartincamalich@ucsd.edu

Anomalies in (semi)leptonic B-meson decays present interesting patterns that might be revealing the shape of the new physics to come. I will review the decays and observables where these appear, discussing the extent up to which the respective SM predictions are understood. In this sense, the most interesting anomaly is, perhaps, the violation of lepton universality implied by a recent measurement of a deficit of $B^+ \to K^+\mu\mu$ over $B^+ \to K^+ee$ decays. This raises very interesting questions concerning the lepton-flavor structure of the presumed new interactions, some of which I will address in the context of effective operators and a particular class of models of new physics.

19

Muon and kaon physics in J-PARC

Corresponding Author(s): natori@post.kek.jp

J-PARC offers one of the most powerful proton beam and is suitable for flavor physics experiments. Kaon and muon experiments are reviewed.

20

Double beta decay with the SNO+ detector

Corresponding Author(s): ericvj@fisica.unam.mx

SNO+ is the successor of the SNO experiment, where the heavy water has been replaced by 780 tons of liquid scintillator (linear alkyl benzene, LAB). SNO+ is located in the SNOLAB underground facility, near Sudbury Ontario Canada, 2 km below the surface to mitigate backgrounds produced by cosmic rays, and in a clean lab environment (class 2000) to reduce external backgrounds. The SNO+ experiment will use the infraestrcuture inherited from SNO, including the 12 m diameter acrylic vessel surrounded by almost 10000 PMTs, with some diverse modifications such as a hold-down rope net system and upgrades to the data acquisition. The physics programme will be initially focused in the search for the neutrinoless double beta decay, by adding tellurium to the scintillator (0.3 % by weight, 160 kg Te-130). The experiment will reach a sensitivity of 9×1025 yrs. (90 % C.L.) after 5 years of data taking. The limit will be reached due to the intense purification programme for the scintillator and tellurium. The physics goals of the experiment also include low energy solar neutrinos, geo and reactor neutrinos, supernova neutrinos if one occurs, as well as nucleon decay and dark matter search through axions. In this talk, I will present the current status of the SNO+ experiment and discuss its physics programme focusing in the double beta decay phase.

21

Leptogenesis in an S3 extension of the Standard Model

Corresponding Author(s): r2d2yo@gmail.com

The S3 model is an extension of the SM in which has been imposed a S3 flavor symmetry. In order to give masses to the particles and keep the flavour symmetry unbroken two additional Higgs doubletes are added. The model has three right handed neutrinos which help implement a seesaw mechanism to give light masses to the left handed ones. On this model we calculate the leptonic as well as the baryonic asymmetry generated from leptogenesis. The renormalization group has been taking into account leading to predictions on the right handed neutrino masses as well as the phases of the masses to the best leptogenesis asymmetry value.

22

Transformative A_4 Neutrino Mixing, CP Violation, and

Dark Matter

Corresponding Author(s): ma@phyun8.ucr.edu

A conceptual shift in the application of A_4 to neutrino mixing and CP violation is presented. It leads to a scotogenic model of neutrino mass with three real neutral scalars.

23

Neutrino CP violation connecting with quark unitarity triangle

Corresponding Author(s): tanimoto@muse.sc.niigata-u.ac.jp

24

neutrinos as gateways to new physics

I review the status of neutrino experiments, and discuss the role of neutrino masses and mixing upon electroweak breaking, unification, and the flavor sector. I show how neutrinos could guide us towards new physics and explain cosmological mysteries

25

Flavon-Higgs mixing effects at future colliders

Corresponding Author(s): jldiaz@fcfm.buap.mx

26

Flavors of Dark Matter - a talk in honor of Ernest Ma's retirement

Corresponding Author(s): jose.wudka@ucr.edu

I will consider a general paradigm of a dark sector interacting with the standard model through a set of heavy neutral mediators, and discuss briefly the various possibilities that emerge. I will then concentrate on the neutrino-portal scenario and present some of its more salient features.

27

T2K neutrino oscillation results and Hyper-Kamiokande future prospects

T2K (Tokai to Kamioka) is a long-baseline neutrino oscillation experiment with a high-intensity beam of muon neutrinos or muon anti-neutrinos produced at the Japan Proton Accelerator Research Complex (J-PARC). A near detector complex 280 m away from the neutrino source provides information about the un-oscillated neutrino flux and interaction cross-sections. The Super-Kamiokande underground water Cherenkov detector, 295 km away, serves as the far detector and measures the oscillated neutrino flux. The T2K experiment conclusively observed electron neutrino appearance in the muon neutrino beam and provided a precise measurement of muon neutrino dissappearance. T2K started taking data using the muon anti-neutrino beam during the summer of 2014 and its first measurement of muon anti-neutrino disappearance has been already released. Hyper-Kamiokande will be a next generation underground water Cherenkov detector with a total (fiducial) mass of 0.99 (0.56) million metric tons, which is about 20 (25) times larger than that of Super-Kamiokande. Together with the upgraded J-PARC neutrino beam, it will be able to study the CP asymmetry in the lepton sector. In this talk, a review of the results on the neutrino oscillation mixing parameters obtained by T2K and the expected sensitivity of Hyper-Kamiokande will be presented.

28

Scalar-fermion and vector fermion vertices connection within spin-extended model

Corresponding Author(s): bespro@fisica.unam.mx

A spin-space extension is reviewed, which provides information on the standard model. Its defining feature is a common matrix space that describes symmetries and representations, and leads to limits on these, for given dimension. The model provides additional information on the standard model, whose interpretation requires an interactive formulation. Within this program, we compare the model's lepton-W generated interactive Lagrangian in (7+1)-dimensions, and that of the standard model. We derive connections between fermion, scalar, and vector representations and their vertices from the model, which leads to information on heavy-quark masses.

29

FSI phases using CP asymmetries from B meson decay

Dr. DOH YOUNG, mo[None]

CP violation phase is required for many beyond the Standard Model (SM) scenarios. Experimental results from BaBar, Belle, and most recently from LHCb are very interesting in this respect. It is important to calculate various CP violation parameters within the SM. In the talk, the final state interaction (FSI) phases with the CKM matrix are calculated using the recent experimental results from LHCb on CP violation in B0 and Bs0 meson decays. To obtain the allowed regions of the FSI phases, a simplified form of the Jarlskog determinant of the CKM matrix is used and the CP phase delta close to the maximal value of pi/2 is found. Then, the asymmetry data on B0 and Bs0 from LHCb is used to explore graphically the allowed regions of the FSI phases.

30

TBA