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Contents

Parallel I / 149

Results from the OPERA experiment in the CNGS beam

Author: Nobuko Kitagawa[1]

[1] *Nagoya University*

Corresponding Author: kitagawa@flab.phys.nagoya-u.ac.jp

The OPERA experiment at the Gran Sasso underground laboratory has recently established nu_mu -> nu_tau oscillations in appearance mode with a significance of 5.1 sigma thanks to the observation of five signal candidate events in a sample with a signal-to-background
ratio of about ten. Now the nu_tau data analysis will be discussed, with emphasis on the background constraints obtained by using dedicated data-driven control samples.
The analysis of the nu_mu -> nu_e channel, formerly based on the first two years of run, also has been extended over the full data set with a more than twofold increase in statistics and the latest result will be reported.
The implications of the tau neutrino and electron neutrino samples in the framework of the 3+1 sterile model will be discussed.

Summary:

Parallel I / 220

Neutrino interaction cross-section measurements

Author: David Payne[1]

[1] *University of Liverpool*

Corresponding Author: djpayne@slac.stanford.edu

Neutrino interaction cross-section measurements on behalf of the T2K collaboration

Summary:

Parallel I / 107

Search for Neutrino Less Double Beta Decay with Majorana Demonstrator

Author: Yuri Efremenko[1]

[1] *University of Tennessee*

Corresponding Author: yefremen@utk.edu

Lepton-number violating neutrinoless double-beta decay plays a major role in determining neutrino properties. If the neutrino has a Majorana nature, detection of neutrinoless double beta decay may provide insight into the neutrino mass. The MAJORANA Collaboration is constructing an ultra-low background, modular high-purity Ge detector array to search for this decay in 76Ge. Located at the 4850-ft level of the Sanford Underground Research Facility, the Demonstrator detector assembly has the goal to show the feasibility of achieving background rates necessary for future ton-scale experiments. After the first commissioning phase last year, more than half of the detectors are in

their final configuration. This talk will give a short introduction to the experiment, the current status of the Demonstrator, as well as plans for the future. This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, the Particle Astrophysics Program of the National Science Foundation, and the Sanford Underground Research Facility.

Summary:

Parallel I / **133**

Results from the NOvA Experiment

Co-author: Robert Group [1]

[1] *University of Virginia*

Corresponding Author: gavin.s.davies@gmail.com

NOvA is a long-baseline accelerator-based neutrino oscillation experiment that is optimized for $\nu_\mu - \nu_e$ measurements. It uses the upgraded NuMI beam from Fermilab and measures ν_e appearance and ν_μ disappearance at its Far Detector in Ash River, Minnesota. The ν_e appearance analysis at NOvA aims to resolve the neutrino mass hierarchy problem and to constrain the CP-violating phase. The first data set of 2.74 x 10^{20} protons on target equivalent exposure taken by was analyzed in 2015 and provided evidence of $\nu_\mu - \nu_e$ oscillation. At PASCOS we plan to update the community with new analyses using approximately twice the beam exposure.

Summary:

Parallel I / **73**

SHiP: a new facility with a dedicated detector to search for new long-lived neutral particles and studying tau neutrino properties

Corresponding Author: ali.murat.guler@cern.ch

SHIP is a new general purpose fixed target facility, whose Technical Proposal has been recently reviewed by the CERN SPS Committee, who recommended that the experiment proceeds further to a Comprehensive Design phase. In its initial phase, the 400GeV proton beam extracted from the SPS will be dumped on a heavy target with the aim of integrating 2×10^{20} pot in 5 years. A dedicated detector, based on a long vacuum tank followed by a spectrometer and particle identification detectors, will allow probing a variety of models with light long-lived exotic particles and masses below O(10) GeV/c^2. The main focus will be the physics of the so-called Hidden Portals, i.e. search for Dark Photons, Light scalars and pseudo-scalars, and Heavy Neutrinos. The sensitivity to Heavy Neutrinos will allow for the first time to probe, in the mass range between the kaon and the charm meson mass, a coupling range for which Baryogenesis and active neutrino masses could also be explained.
Another dedicated detector will allow the study of neutrino cross-sections and angular distributions. ν_τ deep inelastic scattering cross sections will be measured with a statistics 1000 times larger than currently available, with the extraction of the F_4 and F_5 structure functions, never measured so far and allow for new tests of lepton non-universality with sensitivity to BSM physics.

Summary:

Parallel I / 90

New Results from RENO and Future RENO-50 Project

Author: Seon-Hee Seo[1]

[1] *Seoul National University*

Corresponding Author: shseo@phya.snu.ac.kr

RENO (Reactor Experiment for Neutrino Oscillation) is designed to measure
the neutrino mixing angle theta_13 and the effective mass squared difference |dmˆ2_ee|
using electron anti-neutrinos from six reactors at Hanbit nuclear power plant in S. Korea.
RENO has been taking data since August 2011 using two identical detectors at near and far sites.
The unprecedented measurement of the theta_13 by RENO was made in 2012 with 4.9 sigma
significance using 220 live days of data.

In this talk we present the updated sinˆ2(2q13) value and first measurement on |dmˆ2_ee|
based on a spectral shape analysis using 500 live days of data.
And they are sinˆ2 (2theta_13) = 0.082 +- 0.009(stat.) +- 0.006 (syst.) and
|dmˆ2_ee| = 2.62 +0.21 -0.23 (stat.) +0.12 -0.13(syst.) (X 10ˆ-3 eVˆ2).
The systematic uncertainty of sinˆ2(2q13) has improved mainly due to the better estimation of
the Li9/He8 background and the reduction of its uncertainty.
The 5 MeV excess of the electron anti-neutrino events is also discussed.

Towards the end of the talk the current R&D status of RENO-50 project will be presented.

Summary:

Parallel I / 122

The next Enriched Xenon Observatory (nEXO) experiment

Author: Xilei Sun[1]

[1] *IHEP*

Corresponding Author: sunxl@ihep.ac.cn

nEXO is currently in a research and development phase of a 5 tons detector for searching neutrinoless double beta decay of enriched Xe136. The nEXO detector is based on the successfully running EXO200, which has reached a sensitivity for the half life of the decay of 1.9 x 10ˆ25 years with an exposure of 99.8 kgyr. The nEXO experiment will reach a half life sensitivity of > 5 x 10ˆ27 years and cover the inverted neutrino mass hierarchy with 5 years of data. The nEXO detector design, the current R&D, and the physics case for the experiment will be presented in this talk.

Summary:

Parallel I / 111

Degeneracies in long-baseline neutrino experiments from non-standard interactions

Author: Jiajun Liao[1]

Co-authors: Danny Marfatia [1]; Kerry Whisnant [2]

[1] *University of Hawaii at Manoa*

[2] *Iowa State University*

Corresponding Author: liaoj@hawaii.edu

We study parameter degeneracies that can occur in long-baseline neutrino appearance experiments due to nonstandard interactions (NSI) in neutrino propagation. For a single off-diagonal NSI parameter, and neutrino and antineutrino measurements at a single L/E, there exists a continuous four-fold degeneracy (related to the mass hierarchy and θ_{23} octant) that renders the mass hierarchy, octant, and CP phase unknowable. Even with a combination of NOνA and T2K data, which in principle can resolve the degeneracy, both NSI and the CP phase remain unconstrained because of experimental uncertainties.
A wide-band beam experiment like DUNE will resolve this degeneracy if the nonzero off-diagonal NSI parameter is $\epsilon_{e\mu}$. If $\epsilon_{e\tau}$ is nonzero, or the diagonal NSI parameter ϵ_{ee} is $calO(1)$, a wrong determination of the mass hierarchy and of CP violation can occur at DUNE. The octant degeneracy can be further complicated by $\epsilon_{e\tau}$, but is not affected by ϵ_{ee}.

Summary:

Parallel I / 135

Probing Neutrino Mass Hierarchy by Comparing the Charged-Current and Neutral-Current Interaction Rates of Supernova Neutrinos

Author: Guey-Lin Lin[1]

Co-authors: Fei-Fan Lee [1]; Feng–Shiuh Lee [1]; KWANG-CHANG LAI [2]; Tsung-Che Liu [3]; Yi Yang [1]

[1] *National Chiao-Tung University*

[2] *CHANG GUNG UNIVERSITY*

[3] *National Taiwan University*

Corresponding Author: glin@mail.nctu.edu.tw

The neutrino mass hierarchy is one of the neutrino fundamental properties yet to be determined. We introduce a method to determine neutrino mass hierarchy by comparing the interaction rate of neutral current (NC) interactions, $\nu(\overline{\nu}) + p \to \nu(\overline{\nu}) + p$, and inverse beta decays (IBD), $\bar{\nu}_e + p \to n + e^+$, of supernova neutrinos in scintillation detectors. Neutrino flavor conversions inside the supernova are sensitive to neutrino mass hierarchy. Due to Mikheyev-Smirnov-Wolfenstein effects, the full swapping of $\bar{\nu}_e$ flux with the $\bar{\nu}_x$ ($x = \mu,\ \tau$) one occurs in the inverted hierarchy, while such a swapping does not occur in the normal hierarchy. As a result, more high energy IBD events occur in the detector for the inverted hierarchy than the high energy IBD events in the normal hierarchy. By comparing IBD interaction rate with the mass hierarchy independent NC interaction rate, one can determine the neutrino mass hierarchy.

Summary:

Parallel I / 143

Constraining Lorentz Violation with IceCube High Energy Neutrino Data

Author: Wei-Hao Lai[1]

Co-author: Guey-Lin Lin [1]

[1] *National Chiao-Tung University*

Corresponding Author: s30690194@gmail.com

The Lorentz violation effects on the flavor transitions of high energy astrophysical neutrinos are studied. We show that stringent constraints on the Lorentz violation parameters can be derived from recent IceCube flavor ratio measurement on astrophysical neutrinos with energies between 25 TeV and 2.8 PeV. We present our results with both analytical approximations and full numerical calculations.

Summary:

Parallel I / 163

Recent neutrino oscillation results from T2K

Author: Son V Cao[1]

[1] *Kyoto University*

Corresponding Author: cvson@utexas.edu

T2K (Tokai to Kamioka) is the world's first off-axis designed long-baseline experiment that was built for precision measurement of neutrino oscillations. The T2K experiment uses a high intensity, highly pure beam of muon (anti)neutrinos produced at J-PARC in Tokai, Japan. A Near Detector complex, 280 m downstream of the target, is operated to monitor and characterize the (anti)neutrino beam before the neutrinos oscillate. Neutrino oscillation patterns are observed at the Super-Kamiokande detector, which is located 295 km away from the neutrino production point at an angular offset of 2.5 degrees from the average beam direction. T2K has been collecting data with a muon antineutrino beam since 2014 and reported the first results with an exposure of 4.01×10^{20} protons on target in 2015. In this talk, T2K latest results of antineutrino oscillations, including measurements of $\overline{\nu}_\mu \to \overline{\nu}_\mu$ disappearance and $\overline{\nu}_\mu \to \overline{\nu}_e$ appearance, with an additional 85% data will be reported.

Summary:

T2K latest results of antineutrino oscillations, including measurements of $\overline{\nu}_\mu \to \overline{\nu}_\mu$ disappearance and $\overline{\nu}_\mu \to \overline{\nu}_e$ appearance, will be reported.

Parallel I / 164

Favored B_{c} decay modes to search for Majorana neutrino

Author: Sanjoy Mandal[1]

Co-author: Nita Sinha [1]

[1] *The Institute of Mathematical Sciences*

Corresponding Author: smandal@imsc.res.in

First we give the formalism for heavy neutrino mixing with light neutrinos where we extend the SM to include n right-handed SM singlets along with the three generation of left-handed SM SU(2) doublets. We give the calculation of the four body decay $B_c^- \to J/\psi \ell_1^- \ell_2^- \pi^+$ and $B_c \to B_s^0 \ell_1^- \ell_2^- \pi^+$. Explicit form of four monemta is given in the appendix. We calculate the decay width of N in our

interested mass range. We define the quantity $B\left(B_c^- \to \overline{B}_s^0 e^- e^- \pi^+\right) = G_{ee}\left(m_N\right) \frac{|V_{eN}|^4}{\Gamma_N}$ and similarly for $\mu\mu$ and $e\mu$ channels. where, G_{ee} , $G_{\mu\mu}$ and $G_{e\mu}$ are functions of the Majorana mass and depend on the explicit matrix element and phase space for each of the processes. Further we define $F_{ee} \equiv \frac{B^{exp}\left(B_c^- \to \overline{B}_s^0 e^- e^- \pi^+\right)}{G_{ee}(m_N)}$ and similarly for other channels. where B^{exp} are the experimental branching ratio. Upper limits on branching ratio is simply translated to upper limits on mixnig as $\frac{|V_{eN}|^4}{\Gamma_N} < F_{ee}$, $\frac{|V_{\mu N}|^4}{\Gamma_N} < F_{\mu\mu}$, $\frac{|V_{eN}|^2 |V_{\mu N}|^2}{\Gamma_N} < F_{e\mu}/F_{\mu e}$. We calculate the expected number of B_c in LHCb with$\sqrt{s} = 14TeV$ which is around $10^8 - 10^9$ per year. We use this information to set the upperlimit on branching ratio.

Summary:

Recently, the LHCb collaboration reported the observation of the decay mode $B_c^- \to \overline{B}_s^0 \pi^-$ with the largest exclusive branching fraction amongst the known decay modes of all the B mesons. Here we propose a search for a few lepton-number violating ($\Delta L = 2$) decay modes of B_c which can only be induced by Majorana neutrinos. Distinguishing between Dirac and Majorana nature of neutrinos is an outstanding problem and hence, all possible searches for Majorana neutrinos need to be carried out. Since the lepton number violating modes are expected to be rare, when using meson decay modes for these searches one expects CKM favoured modes to be the preferred ones; $B_c \to B_s$ is one such transition. With a resonance enhancement of the Majorana neutrino mediating the $B_c^- \to \overline{B}_s^0 \ell_1^- \ell_2^- \pi^+$ modes, one can hope to observe these rare modes or even their non-observation can be used to obtain tight constraints on the mixing angles of the heavy Majorana singlet with the light flavour neutrinos from upper limits of the branching fractions. Using
these modes we obtain exclusion curves for the mixing angles which are tighter or compatible with results from earlier studies. However, we find that the relatively suppressed mode $B_c^- \to J/\psi \ell_1^- \ell_2^- \pi^+$ can provide even tighter constraints on $\mid V_{eN} \mid^2$, $\mid V_{\mu N} \mid^2$, $\mid V_{eN} V_{\mu N} \mid$, and in a larger range of the heavy neutrino mass. Further, exclusion regions for $\mid V_{eN} V_{\tau N} \mid$, $\mid V_{\mu N} V_{\tau N} \mid$ can also be obtained for masses larger than those accessible in tau decays. Upper limits on $B\left(B_c^- \to \pi^+ \ell_1^- \ell_2^-\right)$ can also result in stringent exclusion curves for all the mixing elements, including that for $\mid V_{\tau N} \mid^2$ in a mass range where it is unconstrained thus far.

Parallel I / 204

Majorana neutrino mass matrices induced by rigid E-brane instantons

Author: Yoshiyuki Tatsuta[1]

Co-authors: Shohei Uemura [2]; Tatsuo Kobayashi [3]

[1] *Waseda Univ.*

[2] *Kyoto Univ.*

[3] *Hokkaido Univ.*

Corresponding Author: y_tatsuta@akane.waseda.jp

We study the effects of D-brane instantons wrapping rigid cycles on the $Z_2 \times Z_2$ toroidal orbifold. We compute Majorana masses induced by rigid D-brane instantons and realize bimaximal mixing matrices in certain models. We can also derive more generic mass matrices in other models. The bimaximal mixing Majorana mass matrix provides a possibility for explaining observed mixing angles. We also compute the μ-term matrix among more than one pair of Higgs fields induced by rigid D-brane instantons.

Summary:

Parallel I / 216

T2K exotics: sterile neutrinos and Lorentz violation searches

Author: Phillip Litchfield[1]

[1] *UCL*

Corresponding Author: p.litchfield@ucl.ac.uk

The long-baseline neutrino experiment T2K uses one of the most intense and well understood GeV-scale neutrino sources in the world, combined with excellent detection capabilities using its near and far detectors. Beyond its primary goal of studying the standard 3-neutrino mixing model, it also provides an opportunity to search for exotic physics in the neutral lepton sector.

From both theoretical and experimental standpoints neutrinos are the least understood of the Standard Model Fermions, so they are a promising sector to look for new physics. A familiar but unresolved question is whether there exist light sterile neutrinos that would produce new oscillation signatures, but there is also the possibility of heavy neutral leptons that would be kinematically distinct. Other searches involving neutrinos that can be performed with T2K will also be covered, such as making use of the long baseline to look for violation of Lorentz invariance.

Summary:

Parallel I / 145

COHERENT experiment at SNS

Author: Yuri Efremenko[1]

[1] *University of Tennessee*

Corresponding Author: yefremen@utk.edu

COHERENT

Coherent, elastic neutrino-nucleus scattering (CEvNS) was first predicted in 1974 as an essential process in the standard model of electroweak interactions. Forty-two years later it is still undetected. Taking advantage of technologies that have recently come to maturity, and the availability of a world-class pulsed neutrino source, the COHERENT collaboration seeks to make the first unambiguous measurement of this process. The Oak Ridge National Laboratory Spallation Neutron Source (SNS) is, as a by-product of the spallation process, the world's most intense pulsed neutrino source. Neutrinos at the SNS are produced as result of decay at rest pions and muons, and therefore the energy spectrum of emitted neutrinos is well suited for CEvNS detection: En < 53 MeV. The pulsed nature and short duty cycle of the SNS beam allow for powerful reductions of backgrounds not associated with the beam. The COHERENT Collaboration is deploying a suite of low threshold detectors (CsI scintillator, high-purity Ge detector array, LAr and NaI scintillator) at the SNS to detect CEvNS, in a manner that limits systematic uncertainties and observes the predicted N-squared-dependence on the cross section. The current status of the collaboration¹s efforts will be discussed and longer-term physics goals of the collaboration will be addressed, including searches for non-standard neutrino interactions and a measurement of the weak mixing angle. Assessments of the backgrounds present in the detector locations will be discussed as well.

Summary:

COHERENT

Coherent, elastic neutrino-nucleus scattering (CEvNS) was first predicted in 1974 as an essential process in the standard model of electroweak interactions. Forty-two years later it is still undetected. Taking advantage of technologies that have recently come to maturity, and the availability of a world-class pulsed

neutrino source, the COHERENT collaboration seeks to make the first unambiguous measurement of this process. The Oak Ridge National Laboratory Spallation Neutron Source (SNS) is, as a by-product of the spallation process, the world's most intense pulsed neutrino source. Neutrinos at the SNS are produced as result of decay at rest pions and muons, and therefore the energy spectrum of emitted neutrinos is well suited for CEvNS detection: En < 53 MeV. The pulsed nature and short duty cycle of the SNS beam allow for powerful reductions of backgrounds not associated with the beam. The COHERENT Collaboration is deploying a suite of low threshold detectors (CsI scintillator, high-purity Ge detector array, LAr and NaI scintillator) at the SNS to detect CEvNS, in a manner that limits systematic uncertainties and observes the predicted N-squared-dependence on the cross section. The current status of the collaboration¹s efforts will be discussed and longer-term physics goals of the collaboration will be addressed, including searches for non-standard neutrino interactions and a measurement of the weak mixing angle. Assessments of the backgrounds present in the detector locations will be discussed as well.

Parallel I / **225**

Hierarchical majorana neutrinos from democratic mass matrices

Author: Masaki Yang[1]

[1] *Saitama University*

Corresponding Author: yang@krishna.th.phy.saitama-u.ac.jp

In this study, we obtain the light neutrino masses and mixings consistent with the experiments, in the democratic texture approach. The essential ansatz is that ν_{Ri} are assumed to transform as "right-handed fields" $\mathbf{2_R} + \mathbf{1_R}$ under the $S_{3L} \times S_{3R}$ symmetry. The symmetry breaking terms are assumed to be diagonal and hierarchical. This setup only allows the normal hierarchy of the neutrino mass, and excludes both of inverted hierarchical and degenerated neutrinos. Although the neutrino sector has nine free parameters, several predictions are obtained at the leading order. When we neglect the smallest parameters ζ_ν and ζ_R, all components of the mixing matrix $U_{\rm PMNS}$ are expressed by the masses of light neutrinos and charged leptons. From the consistency between predicted and observed $U_{\rm PMNS}$, we obtain the lightest neutrino masses m_1 = (1.1 $\rightarrow$ 1.4) meV, and the effective mass for the double beta decay $\langle m_{ee} \rangle \simeq$ 4.5meV.

Summary:

Parallel II / **227**

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Parallel II / **89**

Composite models for 750 GeV diphoton excess at the LHC

Author: Chaehyun Yu[1]

Co-authors: Tzu-Chiang Yuan [1]; pyungwon ko [2]

[1] *Academia Sinica*

[2] *Korea Inst. for Advanced Study (KIAS)*

Corresponding Author: chaehyun@gate.sinica.edu.tw

The diphoton excess at 750 GeV would make a definite signal of new physics beyond the Standard Model, if it is confirmed. We consider a possibility that the excess is due to a composite (pseudo)scalar boson, whose constituents are either new vector-like quarks ($Q\overline{Q}$) or scalar quarks ($\widetilde{Q}\widetilde{Q}^\dagger$) which feel new QCD-like vectorlike confining force with confinement scale Λ_h.
Assuming $m_Q(m_{\widetilde{Q}}) \gg \Lambda_h$, the observed 750 GeV excess could be either $Q\overline{Q}(^1S_0)$ state with $J^{PC} = 0^{-+}$ or $\widetilde{Q}\widetilde{Q}^\dagger(^1S_0)$ state with $J^{PC} = 0^{++}$.
For the $Q\bar{Q}$ scenario, there will be a spin-triplet partner ψ_Q which is slightly heavier that η_Q because of the hyper fine interactions mediated by h-gluon exchange. We consider productions and decays of $\eta_Q, \eta_{\widetilde{Q}}$ and ψ_Q using the nonrelativistic QCD methods, and identify the parameter regions which can explain the observed diphoton excess. We discuss how to test these scenarios using the Drell-Yan process for ψ_Q case, and the dijet azimuthal angular distributions to determine the J^{PC} quantum number of the diphoton excess. This model predicts a new bound state, which is color-singlet in the new QCD, but color-octet in ordinary QCD. We estimate the production cross section of the color-octet bound state at the LHC, which would be a new signal at the LHC.

Summary:

Parallel II / 87

Distinguished LHC signatures of EW scale right-handed 'Fertile' neutrinos

Author: Shreyashi Chakdar[1]

Co-authors: Kirtiman Ghosh [2]; Pham Q. Hung [3]; Satyanarayan Nandi [4]; vinh hoang [5]

[1] *University of Virginia*

[2] *University of Delhi*

[3] *University of Virginia (US)*

[4] *Oklahoma State University*

[5] *university of virginia*

Corresponding Authors: chakdar@virginia.edu, chakdar@okstate.edu

Observation of non-zero neutrino masses at a scale $\sim 10^{-1} - 10^{-2}$ eV is a major problem in otherwise highly successful Standard Model. The most elegant mechanism to explain such tiny neutrino masses is seesaw mechanism with right handed neutrinos. However, the required seesaw scale is so high ($\sim 10^{14}$ GeV), it will not have any direct collider implications. Recently, in our explicit model the seesaw mechanism with the right handed 'fertile'neutrinos at the electroweak scale has been investigated. The model has a mirror symmetry having left and right lepton and quark doublets and singlets for the same $SU(2)_W$ gauge symmetry. Additional Higgs multiplets are introduced to satisfy the precision electroweak tests, and other low energy observables. Because the scale of the symmetry breaking is electroweak, both the mirror quarks and mirror leptons have masses in the electroweak scale in the range $\sim 150 - 800$ GeV. The mirror quarks \ leptons decay to SM quarks \leptons and almost massless neutral scalars. We calculate the final state signals arising from the pair productions of these mirror quarks and leptons and their subsequent decays. We find distinguished like-sign di-lepton signals from mirror lepton decays which are well observable over SM background for 13 TeV LHC. Moreover, depending on the associated Yukawa couplings, these decays can also give rise to displaced vertices with long decay length (very different from the usual displaced vertices associated with b decays), which will be the distinguishing signatures to look for in 13 TeV LHC.

Summary:

Parallel II / 91

Bottom-Tau Unification in Supersymmetric Model with Heavy Sfermions

Author: Takeo Moroi[1]

[1] *The University of Tokyo*

Corresponding Author: moroi.takeo@gmail.com

I discuss the Yukawa unification, in particular, the unification of the Yukawa coupling constants of bottom and tau, in the framework of supersymmetric (SUSY) model. I concentrate on the model in which the SUSY breaking scalar masses are of the order of the gravitino mass while the gaugino masses originate from the effect of anomaly mediation and hence are one-loop suppressed relative to the gravitino mass. I show the results of an accurate calculation of the Yukawa coupling constants of bottom and tau at the grand unified theory (GUT) scale, including relevant renormalization group effects and threshold corrections, and discuss its implication to the Yukawa unification in such a framework.

This presentation will be based on arXiv:1604.02156.

Summary:

Parallel II / 113

Lepton Flavor Violating Decays of Neutral Higgses in Extended Mirror Fermion Model

Authors: Chia-Feng Chang[1]; Chia-Hung Chang[2]; Chrisna Setyo Nugroho[2]; Tzu-Chiang Yuan[3]

[1] *Department of Physics, National Taiwan University, Taipei 116, Taiwan*

[2] *Department of Physics, National Taiwan Normal University, Taipei 116, Taiwan*

[3] *Institute of Physics, Academia Sinica, Taiwan & Physics Division, National Center for Theoretical Sciences, Hsinchu, Taiwan*

Corresponding Author: setyo13nugros@gmail.com

We perform the one-loop induced charged lepton flavor violating decays of the neutral Higgses in an extended mirror fermion model with non-sterile electroweak-scale right- handed neutrinos and a horizontal A4 symmetry in the lepton sector. We demonstrate that for the 125 GeV scalar h there is tension between the recent LHC result $B(h \to \tau\mu) \sim 1\%$ and the stringent limits on the rare processes $\mu \to e\gamma$ and $\tau \to (\mu \text{ or } e)\gamma$ from low energy experiments.

Summary:

Parallel II / 117

An Exploratory study of Higgs-boson pair production

Author: Kingman Cheung[1]

Co-authors: Chih-Ting Lu [2]; Jae Sik Lee [3]; Jung Chang [4]

[1] *Academia Sinica (TW)*

[2] *National Tsing Hua University*

[3] *Chonnam National University*

[4] *National Center for Theoretical Sciences, Physics Division*

Corresponding Author: chang.jung@mx.nthu.edu.tw

Higgs-boson pair production is well known being capable to probe the trilinear self-coupling of the Higgs boson, which is one of the important ingredients of the Higgs sector itself. Pair production then depends on the top-quark Yukawa coupling gS,Pt, Higgs trilinear coupling λ3H, and a possible dim-5 contact-type ttHH coupling gS,Ptt, which may appear in some higher representations of the Higgs sector. We take into account the possibility that the top-Yukawa and the ttHH couplings involved can be CP violating. We calculate the cross sections and the interference terms as coefficients of the square or the 4th power of each coupling (gS,Pt,λ3H,gS,Ptt) at various stages of cuts, such that the desired cross section under various cuts can be obtained by simply inputting the couplings. We employ the HH→γγbb¯ decay mode of the Higgs-boson pair to investigate the possibility of disentangle the triangle diagram from the box diagram so as to have a clean probe of the trilinear coupling at the LHC. We found that the angular separation between the b and b¯ and that between the two photons is useful. We obtain the sensitivity reach of each pair of couplings at the 14 TeV LHC and the future 100 TeV pp machine. We also comment on using the bb¯τ+τ− decay mode.

Summary:

Parallel II / 106

Profiling Z' bosons using charge asymmetry in top pair production with the lepton-plus-jets final state at the LHC

Author: Declan Millar[1]

Co-authors: Francesco Spano [2]; Lucio Cerrito [3]; Stefano Moretti [4]

[1] *University of London (GB)*

[2] *Royal Holloway, University of London (GB)*

[3] *University and INFN Rome 2 (ITALY)*

[4] *STFC - Rutherford Appleton Lab. (GB)*

Corresponding Author: declan.millar@cern.ch

We study the sensitivity of top pair production and six-fermion decay at the LHC to the presence and nature of an underlying Z' boson, accounting for full tree-level Standard Model interference, with all intermediate particles allowed off-shell. We concentrate on the lepton-plus-jets final state and simulate experimental considerations, including kinematic requirements and top quark pair reconstruction in the presence of missing transverse energy and combinatorial ambiguity in jet-top assignment. We focus on the differential mass spectra, as well as the charge asymmetry, demonstrating the use of this asymmetry in probing the coupling structure of a new neutral resonance, as well as cases in which the asymmetry forms a complementary discovery observable.

Summary:

Parallel II / 110

Exploring minimally flavor violating Higgs decays

Author: Jusak Tandean[None]

Corresponding Author: jtandean@phys.ntu.edu.tw

We consider the tentative hint of Higgs boson decay $h \to \mu\tau$ recently seen in LHC data in a grand unified theory framework which is based on the SU(5) gauge group and implements the principle of minimal flavor violation. This allows us to explore the possibility that this decay has some link to potential new physics in the quark sector. We look at different simple scenarios in this context and how they are subject to various empirical restrictions. In one specific case, the relative strengths of the flavor-changing leptonic Higgs couplings are determined mainly by the known quark mixing parameters and masses, and a branching fraction $B(h \to \mu\tau) \sim 1\%$ is achievable without the couplings being incompatible with the relevant constraints. Upcoming measurements on Higgs leptonic decays and searches for the $\mu \to e\gamma$ decay with improved precision can offer further tests on this scenario.

Summary:

Parallel II / 144

Beam polarizaton eects on top anti-top pair production at ILC

Author: Nhi Quach[1]

[1] *KEK*

Corresponding Author: nhiquach@post.kek.jp

The Standard Model is a very beautiful model yet there are still some remain questions which we are curious
about. The Large Hadron Collider (LHC) may or may not provide some of the answers to some some of these
questions. The future international electron-positron collide (ILC) with 200-500 GeV (extendable to 1 TeV)
center of mass high luminosity may provide a window into some of the mysteries that we are hoping to solve.
Which state that our Universe lies in is one of the most crucial and interesting topic for physicists, thus the
precise measurement of the top quark properties is important and necessary. In this thesis, we would like to
discuss this process: e+e ! tt. Using GRACE system with polarization, we present the dierence between
the total cross section as the function of CM energy of tt pair production with the left-handed electron and
right-handed positron initial polarization in both tree level and full electroweak correction. The cross section
with e
Le+
R polarization is larger than the cross section with e
Re+
L polarization. Nevertheless, the radiative
correction of e
Le+
R polarization is smaller than the radiative correction of e
Re+
L polarization. The angular
distributions also conrm this behavior due to the eects of the polarization. For the top quark, since the
forward-backward asymmetry AFB of the top quark is considerable among unpolarized case, left-right and

right left polarization, it should be taken into account at ILC. We also show the property of top quark decay
t ! b + + + included the nal polarization. We conclude that by using GRACE system with the eect of polarization, we can distinguish the left-right and right-left for the total cross section, angular distribution,
forward-backward asymmetry at tree level and full electroweak correction. Especially for the top quark, we are
able to calculate with both initial and nal polarization. In conclusion, polarization eects are essential to gure
out the properties of fermions especially the top quark at the future ILC. With GRACE system, total cross
section, angular distribution, energy distribution can be calculated with beam initial and nal polarization for
both tree level and full electroweak correction.
1

Summary:

Parallel II / 116

Interpreting the 750 GeV Di-photon Resonance using photon-jets in Hidden-Valley-like models

Author: Chih-Ting Lu[1]

Co-authors: Jung Chang ; Kingman Cheung [2]

[1] *National Tsing Hua University*

[2] *Academia Sinica (TW)*

Corresponding Author: timluyu@hotmail.com

Motivated by the di-photon resonance recently reported by the ATLAS and CMS collaborations at 13 TeV, we interpret the resonance as a scalar boson X(750) in hidden-valley-like models. The scalar boson X can mix with the standard model Higgs boson and thus can be produced via gluon fusion. It then decays into a pair of very light hidden particles Y of sub-GeV, each of which in turn decays to a pair of collimated pions, and these two pions decay into photons which then form photon-jets. A photon-jet is a special feature that consists of a cluster of collinear photons from the decay of a fast moving light particle (sub-GeV). Because these photons inside the photon-jet are so collimated that it cannot be distinguished from a single photon, and so in the final state of the decay of X(750) a pair of photon-jets look like a pair of single photons, which the experimentalists observed and formed the 750 GeV di-photon resonance. Prospects for the LHC Run-2 about other new and testable features are also discussed.

Summary:

Parallel II / 119

Phenomenology of minimal Z'models: from the LHC to high energy scales

Authors: Carlo Marzo[1]; Claudio Coriano[2]; Elena Accomando[3]; Juri Fiaschi[4]; Luigi Delle Rose[4]; Stefano Moretti[5]

[1] *Università del Salento*

[2] *Unknown*

[3] *Southampton University*

[4] *University of Southampton*

[5] *STFC - Rutherford Appleton Lab. (GB)*

Corresponding Author: l.delle-rose@soton.ac.uk

We consider a class of minimal abelian extensions of the Standard Model (SM) with an extra neutral gauge boson Z'at the TeV scale. In these scenarios an extended scalar sector and heavy right-handed neutrinos are naturally envisaged. We present some of their striking signatures at the Large Hadron Collider, the most interesting
arising from a Z'decaying to heavy neutrino pairs as well as a heavy scalar decaying to two SM Higgs. Using renormalisation group methods, we characterise the high energy behaviours of these extensions and we exploit the constraints imposed by the embedding into a wider GUT scenario.

Summary:

Parallel II / 125

Exotic Zγ Search with the ATLAS Detector and its Implication to the 750 GeV γγ Excess

Author: Dart-yin Soh[1]

[1] *Institute of Physics-Academia Sinica*

Corresponding Author: dartyin@cern.ch

We investigate the possibility that the widely discussed ~ 750 GeV $\gamma\gamma$ excesses at the 2015 $13TeV$ collisions at the LHC can be explained by the vector boson fusion production rather than the gluon-gluon fusion production which was assumed by most of the phenomenological models, by considering the available kinematics distributions from ATALS and CMS results. We propose a model with extra scalar hypothetical particles rather than extra coloured vector-like quarks.

Summary:

Parallel II / 118

Constraints on non-universal gaugino mass scenario using the latest LHC data

Author: Junichiro Kawamura[1]

Co-author: Yuji Omura [2]

[1] *Waseda University*

[2] *Nagoya University*

Corresponding Author: junichiro-k@ruri.waseda.jp

In our work, we investigate exclusion limits on the parameter space of the Non-Universal Gaugino Mass (NUGM) scenario
where a natural SUSY spectrum is achieved due to a relatively heavy wino mass parameter. We calculated the bound on the mass of top squark, which is almost right-handed and then it can decay into both $t\tilde{\chi}^0_{1,2}$ and $b\tilde{\chi}^{\pm}_1$. The top squark mass is roughly controlled by the bino mass parameter since the RG contributions from the gluino and the wino mass parameters are canceled each other

in the light higgsino region. Thus the top squark searches at the LHC Run I and Run II can constrain parameter region with the small bino mass parameter and the large gluino mass parameter. The top squark lighter than 700 GeV is excluded at $\mu \leq 150$ GeV, and lighter than 600 GeV is excluded at $\mu \leq 300$ GeV according to the result of the search for $bb + E_T^{\rm miss}$ at the LHC Run II. This limit already exceeds the one from the LHC Run 1 data. This lower bound corresponds to $M_1 \geq 6.0$ TeV for $\mu \sim 150$ GeV and $M_1 \geq 5.0$ TeV for $\mu \sim 300$ GeV. Note that there is no bound from the top squark search when $\mu \geq 300$ GeV. Gluino search is also good probes to the NUGM scenario due to the large production cross section.
According to the LHC results, the parameter space with the small gluino mass and the large bino mass can be covered in our scenario. Note that the top squark is tachyonic in the parameter region where both bino and gluino masses are small.
The gluino mass less than 1.55 TeV is excluded by the ATLAS result at the LHC Run II when μ satisfies $\mu \leq 500$ GeV. We can conclude that the parameter region with $M_3 < 650$ GeV and $\mu \leq 500$ GeV is already excluded. Bottom squark mass can be same or lighter than top squark mass
if $\tan\beta$ is so large that the bottom Yukawa coupling becomes sizable. Since the behavior of bottom squark at the collider experiment is quite similar to the one of top squark,
the top squark search discussed above is also sensitive to the events generated by the bottom squarks. The wider region is prohibited theoretically compared with the small $\tan\beta$ case, in order to avoid the tachyonic bottom squarks or the tau slepton. The exclusion limit on the bino mass parameter reaches to $M_1 \simeq 12$ TeV for $M_3 \simeq 800$ GeV,
and it reduces to 6.0 TeV as M_3 increases.

Summary:

We investigate exclusion limits on the the non-universal gaugino mass scenario
in the Minimal Supersymmetric Standard Model (MSSM), according the the latest results of the super-particle search at the LHC8 and the LHC13. In this scenario, suitable ratios of wino to gluino mass can realize the observed value of the Higgs boson mass, while keeping a small μ parameter.
Such a small μ parameter corresponds to the mass of higgsino, so that
lightest neutralino and chargino are higgsino-like and their masses are almost degenerate.
Besides, we find that the right-handed top squark tends to be lighter than other sfermions
and then the top squark search, where the top squark decays to a quark and higgsino, is relevant to our model.
In our analysis, the exclusion limits are derived using the data of the top squark searches
in the $bb + E_T^{\rm miss}$ and $tb + E_T^{\rm miss}$ channels.
Furthermore, the exclusion limit on gluino mass, which is crucial to our scenario, is investigated as well. The analysis of the gluino is based on the data of the analysis with large missing energy and at least three b-tagged jets at the ATLAS experiment.
This work is based on PTEP 2013 (2013) 013B02, JHEP 1508 (2015) 089 and PRD 93 (2016) no.5, 055019.

Parallel II / **105**

Mass composition and shower physiscs studies with the data of the Surface Detector of the Pierre Auger Observatory

Author: Patricia Sanchez-Lucas[1]

[1] *University of Granada*

Corresponding Author: patriciasl@ugr.es

The Pierre Auger Observatory is the largest detector ever built. With an area covering over 3000 km2, it was designed for the detection of ultra high energy cosmic rays. Using an original hybrid technique the Observatory can measure both the longitudinal profile in the atmosphere and the lateral distribution of particles at the ground, which allows the study of the extensive air showers in two complementary ways. We present here the last results related to mass composition inferences and air shower physics obtained with observables measured by the surface detector (SD). For mass studies, we are focused on the muon production depth in the atmosphere and the azimuthal asymmetry of the risetime, We also discuss how those observables together with the measurement of the muon number at the ground can be used to constrain hadronic interaction models.

Summary:

Parallel II / 140

Singlet-doublet mixing in NMSSM and approximate scale symmetries

Authors: Hiroki Makino[1]; Kei Hagimoto[1]; Ken-ichi Okumura[1]; Takashi Shimomura[2]; Tatsuo Kobayashi[3]

[1] *Kyushu University*

[2] *Miyazaki University*

[3] *Hokkaido University*

Corresponding Author: okumura@phys.kyushu-u.ac.jp

LHC Run I discovered the Higgs boson and revealed that it has properties almost predicted by the SM, like spin, parity and couplings to the other SM particles.
If there exists additional light bosons having the same quantum numbers with the Higgs boson, they will mix with it through the off-diagonal mass terms.
This mixings modify the couplings of the Higgs boson and also generate couplings of the new bosons to the SM particles.
In this talk, we take the Next-to-Mininal Supersymmetric Standard Model as an example and discuss that approximate scale symmetries are useful to suppress the singlet-doublet mixing which prevents the Higgs boson mass achieving 125 GeV if the singlet-like boson is heavier than the Higgs boson and is tightly constrained from the LEP Higgs boson search if the singlet-like boson is lighter than the Higgs boson.

Summary:

Parallel II / 96

Holographic approach to electron–photon deep inelastic scattering at small x

Author: Akira Watanabe[1]

Co-author: Hsiang-nan Li [1]

[1] *Institute of Physics, Academia Sinica*

Corresponding Author: akira.watanabe.hep@gmail.com

A photon is a fundamental particle, instead of a nonperturbative composite like hadrons. However, an energetic photon can fluctuate into vector mesons in the kinematic region with a small Bjorken variable $x < 0.1$. Particularly at $x < 0.01$, the hadronic contribution to cross sections of the electron–photon deep inelastic scattering dominates, and a photon can be regarded as a hadron rather than a pointlike object. Therefore, effective models are needed for studies of the photon structure in this region. We present analysis on the photon structure functions at small x in the framework of the holographic QCD, assuming dominance of the Pomeron exchange. The quasi-real photon structure functions are expressed as convolution of the Brower–Polchinski–Strassler–Tan (BPST) Pomeron exchange kernel and the known wave functions of the U(1) vector field in the five-dimensional AdS space, in which the adjustable parameters in the BPST kernel have been fixed in previous studies of the nucleon structure functions. The predicted photon structure functions, as confronted with experimental data, provide a clean test of the BPST kernel. The agreement between theoretical predictions and data is demonstrated, which supports applications of holographic QCD to hadronic processes in the nonperturbative region. Our calculations are also consistent with those derived from

the parton distribution functions of the photon proposed by Glück, Reya, and Schienbein, implying realization of the vector meson dominance in the present model setup. Our results presented in this talk will be tested at future linear colliders, e.g., the planned International Linear Collider.

Summary:

Parallel II / 126

Large loop-coupling enhancement of a 750 GeV pseudoscalar from a light dark sector

Author: Stefano Di Chiara[1]

[1] *NICPB*

Corresponding Author: stefano.dichiara@kbfi.ee

In this talk I will first show how the relatively large effective couplings, required by the 750 GeV diphoton signal, can be the result of a threshold enhancement in the loop coupling between a heavy pseudoscalar particle and new leptons and quarks with masses of about 375 and 700 GeV, respectively. I will then present a model in which the new charged leptons avoid detection by decaying to a natural dark matter candidate, and demonstrate that such model is able to fit the observed diphoton signal while satisfying the experimental bounds on the other decay channels and retaining perturbativity up to scales as high as 10^9 GeV. Finally, I will show that the dark matter experimental bounds are satisfied within the parameter space region viable at LHC.

Summary:

Parallel II / 148

Heavy Axion Solution of the Strong CP Problem

Author: Archil Kobakhidze[1]

[1] *The University of Sydney*

Corresponding Author: archil.kobakhidze@coepp.org.au

I discuss a new axionic solution to the strong CP problem which involves a hypothetical vector-like quark(s) in a high-colour representation of the conventional QCD. There are two distinct scenarios. If the current mass of the exotic quark is zero, the strong CP phase can be trivially rotated away. The high-colour quark is 'hidden' in various bounds states, the lightest being the composite axion field, with properties similar to the standard invisible axion. If the high-colour quark acquire a non-zero current mass due to the spontaneous chiral symmetry breaking, the composite axion can be heavy, while the strong CP phase is still cancelling out in the vacuum. I also speculate that this heavy axion can be the 750 GeV diphoton resonance apparently seen in the early LHC Run 2 data.

Summary:

Parallel II / 158

Vacuum stablility and SUSY at high scales with two Higgs doublets

Author: Felix Bruemmer[1]

[1] *Université de Montpellier*

Corresponding Author: felix.bruemmer@umontpellier.fr

We consider two-Higgs doublet models (THDMs) with a supersymmetric UV completion. Contrary to the Standard Model, THDMs can be embedded in high-scale supersymmetry with a SUSY breaking scale as high as the scale of grand unification. The stability of the electroweak vacuum and experimental constraints point towards low values of tan(beta) < 2 and a pseudoscalar mass of at least about a TeV. If the higgsino superpartners of the Higgs fields are also kept light, the conclusions are similar and essentially independent of the higgsino mass. However, if all gauginos are also given electroweak-scale masses (split supersymmetry with two Higgs doublets), the predicted Standard Model-like Higgs mass is always too large. Light neutral and charged higgsinos emerge as a promising signature of minimal theories with supersymmetric UV completions at high scales, and can be searched for at colliders.

Summary:

Parallel II / 162

Search for low mass Higgs-boson like resonances at CMS

Author: Junquan Tao[1]

[1] *Institute of High Energy Physics, Chinese Academy of Sciences (CN)*

Corresponding Author: junquan.tao@cern.ch

Searches for additional scalars and pseudoscalar with masses below the newly discovered higgs boson h(125) are performed at CMS experiment . These searches are motivated within several BSM theories, most significantly extensions of the mininal extensions of the MSSM like the NMSSM, where additional scalar and pseudoscalar states are expected. The mass range from 250 MeV to 110 GeV is explored with different final states based on CMS Run1 data.

Summary:

Parallel II / 205

A Model of Heavy QCD Axion and the LHC Signature

Author: Hajime Fukuda[1]

Co-authors: Cheng-Wei Chiang [2]; Masahiro Ibe [3]; Osamu Jinnouchi [4]; Tsutomu Yanagida [5]; mihoko nojiri [6]

[1] *The University of Tokyo*

[2] *National Central University, Taiwan*

[3] *ICRR, The University of Tokyo*

[4] *Tokyo Institute of Technology (JP)*

[5] *Kavli IPMU, The University of Tokyo*

[6] *KEK*

Corresponding Author: hajime.fukuda@ipmu.jp

As Rubakov suggested in 1997, an QCD axion can be heavy if there is a copy of the Standard Model and a Peccei-Quinn symmetry is realized between it and the Standard Model.
Following that idea, we construct a concrete model which satisfies the cosmological consistency.

Then, some of the resultant particles can be around the region which is accessible by the LHC. We point out that the dilaton in our model can play a role of the diphoton signal. Although the dilaton-photon-photon coupling is weaker than the dilaton-axion-axion one, an axion is much lighter than a dilaton and the two photons from an axion is quite collimated, mimicking a photon signal.

We also investigate how to distinguish this mimicking signal in a preparing work. Using the information from the tracker, we conclude that using some kinds of distributions, it is possible to reveal the property.

Summary:

We have constracted a model of heavy QCD axion in 1504.06084 and a preparing paper and discussed the LHC signature associating it with the diphoton signal in 1602.07909 and one in preparation.
In the talk, I will review how we can make an axion heavy and the validity of the LHC signature.

Parallel II / 218

Search for a high mass diphoton resonance using the ATLAS detector

Author: Andrew HARD[1]

[1] *University of Wisconsin*

Corresponding Author: ahard@cern.ch

A search for resonances decaying to two photons was conducted with the ATLAS Experiment at the LHC. The analysis used proton-proton collision data with a center-of-mass energy of sqrt(s)=13 TeV and an integrated luminosity of 3.2/fb. Searches were performed for spin-0 particles at masses greater than 200 GeV and spin-2 particles at masses greater than 500 GeV. Limits on the production cross-section times branching ratio to two photons for both resonance types were computed. The largest local deviations from the background-only hypothesis are observed at a diphoton invariant mass of 750 GeV and correspond to 3.9 and 3.8 standard deviations for the spin-0 and spin-2 hypotheses, respectively. The global significances of the excesses of events are both 2.1 standard deviations.

Summary:

A search for resonances decaying to two photons was conducted with the ATLAS Experiment at the LHC. The analysis used proton-proton collision data with a center-of-mass energy of sqrt(s)=13 TeV and an integrated luminosity of 3.2/fb. Searches were performed for spin-0 particles at masses greater than 200 GeV and spin-2 particles at masses greater than 500 GeV. Limits on the production cross-section times branching ratio to two photons for both resonance types were computed. The largest local deviations from the background-only hypothesis are observed at a diphoton invariant mass of 750 GeV and correspond to 3.9 and 3.8 standard deviations for the spin-0 and spin-2 hypotheses, respectively. The global significances of the excesses of events are both 2.1 standard deviations.

Parallel III / 93

Axion as a cold dark matter candidate: fully relativistic and non-linear analysis

Author: Jai-chan Hwang[None]

Co-authors: Chan-Gyung Park [1]; Hyerim Noh [2]

[1] *Jeonbuk National University*

[2] *Korea Astronomy and Space Science Institute*

Corresponding Author: jchanhwang@gmail.com

We investigate aspects of axion as a coherently oscillating massive classical scalar field by analyzing the fully nonlinear order perturbations in Einstein's gravity in the axion-comoving gauge.
The axion fluid has its characteristic pressure term leading to an axion Jeans scale which is cosmologically negligible for a canonical axion mass.
Our classically derived axion pressure term in Einstein's gravity is identical to the one derived in the non-relativistic quantum mechanical context in the literature.
We present the general relativistic energy and momentum conservation equations for an axion fluid valid up to fully nonlinear order in perturbation.

Summary:

Parallel III / 231

free time

Parallel III / 94

Estimating J-factors of dSphs for indirect dark matter detections

Author: Shigeki Matsumoto[1]

[1] *Kavli IPMU, U. Tokyo*

Corresponding Author: shigeki.matsumoto@ipmu.jp

The TeV scale WIMP having a weak charge (e.g. Wino, Higgsino) recently attracts many attentions. While such a WIMP is hard to be detected at collider and direct dark matter detection experiments, it is expected to be efficiently searched for at indirect dark matter detection experiments, for its annihilation cross section is boosted by the Sommerfeld enhancement. Among various indirect detection methods, observing gamma-rays from dSphs are thought to be the most robust way to detect the WIMP. On the other hand, we have to know how the WIMP is distributed inside each dSph to predict the signal flux accurately. In this talk, I would like to talk about recent developments on determining the distributions (i.e. J-factors) based on the paper arXiv:1603.08046.

Summary:

Parallel III / **69**

Phenomenology of electroweak multiplets as dark matter candidates.

Author: Marco Taoso[1]

[1] *IFT, Universidad Autonoma de Madrid, Spain*

Corresponding Author: marco.taoso@gmail.com

Electroweak multiplets are arguably among the simplest and best motivated WIMP dark matter candidates.
I will discuss their relevant phenomenology in the light of current and future experimental searches. Predictions for searches at the high-luminosity LHC, and at an 100 TeV pp collider will be presented. Then, I will analyze indirect detection probes. I will compare the predictions of the models, with a particular focus on Minimal Dark Matter, with the most recent bounds. I will discuss the impact of astrophysical uncertainties on current constraints and I will present predictions for future surveys.

Summary:

Parallel III / **78**

Simplified DM models with the full SM gauge symmetry

Authors: Alexander Natale[1]; Hiroshi Yokoya[2]; Myeonghun Park[3]; pyungwon ko[4]

[1] *Korea Institute for Advanced Study*

[2] *University of Toyama*

[3] *Asia Pacific Center for Theoretical Physics (APCTP) (KR)*

[4] *Korea Inst. for Advanced Study (KIAS)*

Corresponding Author: alex.anderson.natale@gmail.com

The general strategy for dark matter (DM) searches at colliders currently relies on simplified models, which typically have a limited number of free parameters. In the case of t-channel colored mediators, these simplified models often have assumptions on the chirality of the DM-SM interactions with quarks, though generically a UV-complete model with such colored mediators would lead to the existence of more free parameters. In this study we look at the effect this broader set of free parameters has on direct detection and the mono-X + MET (X=jet,W,Z) signatures at 13 TeV LHC while maintaining gauge invariance of the simplified model under the full SM gauge group. We find that the direct detection constraints require DM masses less than 10 GeV in order to produce phenomenologically interesting collider signatures. Additionally, for a fixed mono-W cross section it is possible to see very large differences in the mono-jet cross section when the usual simplified model assumptions are loosened and isospin violation between RH and LH DM-SM quark couplings are allowed.

Summary:

Parallel III / **99**

Effects of Goldstone bosons on gamma-ray bursts

Author: Huitzu Tu[1]

Co-author: Kin-Wang Ng [1]

[1] *Institute of Physics, Academia Sinica*

Corresponding Author: huitzu2@gate.sinica.edu.tw

Gamma-ray bursts (GRBs) are the most energetic explosion events in the universe.
An amount of gravitational energy of the order of the rest-mass energy of the Sun is released from a small region within a short time.
This should lead to the formation of a fireball of temperature in the MeV range, consisting of electrons/positrons, photons, and a small fraction of baryons.
We exploit the potential of GRB fireballs for being a laboratory for testing particle physics beyond the Standard Model, where we find that Weinberg's Higgs portal model serves as a good candidate for this purpose.
Due to the resonance effects, the Goldstone bosons can be rapidly produced by electron-positron annihilation process in the initial fireballs of the gamma-ray bursts.
On the other hand, the mean free path of the Goldstone bosons is larger than the size of the GRB initial fireballs, so they are not coupled to the GRB's relativistic flow and can lead to significant energy loss.
Using generic values for the GRB initial fireball energy, temperature, radius, expansion rate, and baryon number density, we find that the GRB bounds on the parameters of Weinberg's Higgs portal model are indeed competitive to current laboratory constraints.

Summary:

Parallel III / 98

NEWS: Nuclear Emulsions for WIMP Search

Author: Murat Ali Guler[1]

[1] *Middle East Technical University (TR)*

Corresponding Author: ali.murat.guler@cern.ch

In this talk, the present status of the experiment will be presented. A new exculusion limit and sensitivity for A NIT detector with an exposure of 1 kgxyear including directionality information will be presented.

Summary:

Nowadays there is compelling evidence for the existence of dark matter in the Universe. A general consensus has been expressed on the need for a directional sensitive detector to confirm, with a complementary approach, the candidates found in "conventional"searches and to finally extend their sensitivity beyond the limit of neutrino-induced background. We propose here the use of a detector based on nuclear emulsions to measure the direction of WIMP-induced nuclear recoils. The production of nuclear emulsion films with nanometric grains has been recently established. Several measurement campaigns have demonstrated the capability of detecting sub-micrometric tracks left by low energy ions in such emulsion films with nanometric grains. Innovative analysis technologies with fully automated optical microscopes have made it possible to achieve the track reconstruction for path lengths down to one hundred nanometres and there are good prospects to further exceed this limit. The detector concept we propose foresees the use of a bulk of nuclear emulsion films surrounded by a shield from environmental radioactivity, to be placed on an equatorial telescope in order to cancel out the effect of the Earth rotation, thus keeping the detector at a fixed orientation toward the expected direction of galactic WIMPs. We report the performances and the schedule of the NEWS experiment, with its one-kilogram mass pilot experiment, aiming at delivering the first results on the time scale of five years.

Parallel III / **115**

Dark Astronomical Compact Objects in Inflationary Dark Matter model

Authors: Dat Duong[1]; Pham Q. Hung[2]

[1] *University of Virginia*

[2] *University of Virginia (US)*

Corresponding Author: dqd8tp@virginia.edu

Nearly 80% of matter in the Universe is dark matter although its nature is as mysterious as its name. By using the dark matter in Inflationary Dark Matter model proposed by P. Q. Hung and P. Frampton, we examine the possibility of the formation of Dark Astronomical Compact Objects (DACOs) along with their physical properties such as masses, radii and their stability. We also propose an energy dissipation mechanism, which is a requirement for a dark matter gravitationally bounded system to be formed.

Summary:

Parallel III / **124**

Updates from the PandaX-II experiment

Author: Pengwei Xie[1]

[1] *Shanghai Jiao Tong University*

Corresponding Author: landynew@gmail.com

The PandaX dark matter experiment searches WIMP-nucleon scattering signals in the China Jin-Ping Underground Laboratory (CJPL) with a rock burden of 2400 m, employing dual-phase xenon time projection chamber technology. After the completion of PandaX-I, the upgraded experiment, PandaX-II, has been equipped with a 580 kg active xenon target. A commissioning run was carried out in CJPL late in 2015. In this talk, I will present the results from the commissioning run, as well as give an update of the current status of the experiment.

Summary:

Parallel III / **134**

The dual light-emitting crystals detector for WIMPs direct searches

Author: Xuan Zhang[1]

Co-author: Xilei Sun [2]

[1] *Institute of High Energy Physics of Chinese Academy of Sciences*

[2] *IHEP*

Corresponding Author: zhangxuan@ihep.ac.cn

The dual light-emitting crystals can reflect the different ranges of nuclear recoils and electron recoils by the ratio of the two different scintillation components. CsI(Na) crystals at temperatures of -160℃ have the best performance in several candidate crystals. An experiment called CINDMS is proposed for WIMPs direct searches based on the CsI(Na) crystals detector by IHEP. The 1T-scale experimental threshold is expected to be in the world advanced level through the background estimates. The initial stage of a 40 kg scale experiment was constructed at Daya Bay neutrino experiment underground laboratory for the accumulation of technology. 3 months of background data were collected at the temperature of -160℃, -120℃ and room temperature. CINDMS1T or more large-scale experiment may be located deep underground laboratory of Jinping Mountain in Sichuan, China. This location provides vastly improved shielding from cosmogenic events which will reduce interference of known backgrounds particles.

Summary:

Parallel III / 136

Direct Dark Matter Detection with XENON1T

Author: Julien on behalf of the XENON collaboration Wulf[1]

[1] *University of Zürich*

Corresponding Author: jwulf@physik.uzh.ch

Observations at cosmological and astronomical scales indicate that the majority of matter in our Universe is in the form of non-relativistic and long-lived dark matter. Its observed relic abundance is consistent with the existence of a neutral, massive particle with little or no self-interaction. A dark matter candidate favoured by extensions of the Standard Model is a Weakly Interacting Massive Particle (WIMP) whose interaction with normal matter can be probed directly via elastic scattering off target nuclei, thus motivating searches through direct detection. XENON1T, a dual-phase time projection chamber using a 1-ton liquid xenon fiducial volume, was recently constructed in the Laboratori Nazionali del Gran Sasso. It aims to observe primarily low-energy nuclear recoils of WIMPS with unprecedented sensitivity. This presentation gives a status of the XENON1T experiment and describes the XENON1T detector, an initial characterization of the detector, and the predicted sensitivity based on Monte Carlo simulations.

Summary:

Parallel III / 138

Recent Results at Ultra-high Cosmic Ray Energies from the Pierre Auger Observatory.

Author: Roger Clay[1]

[1] *University of Adelaide*

Corresponding Author: roger.clay@adelaide.edu.au

Cosmic rays have a measured energy spectrum which extends past 100 EeV, with ECM above 100 TeV. Their interactions in the atmosphere thus probe energies past the LHC, but without a controlled experimental environment and with a very low flux.

The Pierre Auger Observatory studies atmospheric cascades, produced by ultra-high energy cosmic rays, with a collecting area of 3000 square kilometres and has a useful count rate even above 10 EeV (beginning below 1 EeV). The Observatory makes measurements to aid an understanding of the

sources of the highest energy particles in Nature, but it also studies the accessible properties of interactions at those energies with the aid of models based on extrapolated data from accelerators.

Recent results from the Pierre Auger Observatory on astrophysical and particle physics issues will be discussed in this presentation.

Summary:

Parallel III / **104**

High-resolution SZ cartography of clusters of galaxies with the NIKA camera at the IRAM 30-m telescope

Author: Frederic Mayet[1]

[1] *LPSC Grenoble*

Corresponding Author: mayet@lpsc.in2p3.fr

I will present recent Sunyaev-Zeldovich observations of clusters of galaxies with the NIKA prototype at the IRAM 30-m telescope together with the forthcoming tSZ observation program with the NIKA2 camera.

Summary:

Arcmin resolution thermal Sunyaev-Zeldovich (tSZ) observations (e.g. SPT, ACT and Planck) only allowed detailed studies of the intra cluster medium morphology for low redshift clusters (z < 0.2).
The development of precision cosmology with clusters requires high-angular resolution observations to extend the understanding of galaxy cluster towards high redshift. NIKA2 is a wide-field (6.5 arcmin field of view) dual-band camera, operated at 100 mK and containing ˜ 3500 KID (Kinetic Inductance Detectors), designed to observe the millimeter sky at 150 and 260 GHz,
with an angular resolution of 18 and 12 arcsec respectively.
The NIKA2 camera has been installed on the IRAM 30-m telescope (Pico Veleta, Spain) in September 2015.
The NIKA2 tSZ observation program will allow us to observe a large sample of clusters (50) at redshifts above 0.5. As a pathfinder for NIKA2, several clusters of galaxies have been observed at the IRAM 30-m telescope with the NIKA prototype to cover the various configurations and observation conditions expected for NIKA2.

Parallel III / **112**

Searches for Axion-Like Particles with NGC1275: Observation of Spectral Modulations

Author: Markus Rummel[None]

Corresponding Author: markus.rummel@physics.ox.ac.uk

Axion-like particles (ALPs) can induce localised $\mathcal{O}(10\%)$ oscillatory modulations in the spectra of photon sources passing through
astrophysical magnetic fields. Ultra-deep Chandra observations of the Perseus cluster contain over 5×10^5 counts from the central AGN, NGC1275, and represent a dataset of extraordinary quality for ALP searches.

We use this dataset to search for X-ray spectral irregularities from the AGN. The absence of irregularities at
the $\mathcal{O}(30\%)$ level allows us to place leading constraints on the ALP-photon mixing
parameter $g_{a\gamma\gamma} \leq 1.5 - 5.4 \times 10^{-12}\text{GeV}^{-1}$ for $m_a \leq 10^{-12}$ eV, depending on assumptions on the magnetic field realisation along the line of sight.
At $\mathcal{O}(10\%)$ level two modulations are present at high statistical significance, an excess in the 2-2.2 keV region and a
deficit at 3.4-3.5 keV. We are unable to account for these through conventional instrumental or astrophysical
processes and, interpreted as a signal, they would correspond to an ALP-photon coupling in the range $g_{a\gamma\gamma} \sim 1 - 5 \times 10^{-12}\text{GeV}^{-1}$.

Summary:

Parallel III / 166

Measuring Velocity Distribution of Dark Matter by Directional Detection

Author: Keiko Nagao[None]

Co-author: Tatsuhiro Naka [1]

[1] *Nagoya University*

Corresponding Author: nagao.i.keiko@gmail.com

Direct detection of dark matter in which we can observe not only the recoil energy but also the direction, will be forthcoming generation project. I will discuss the possibility to measure the velocity distribution of dark matter using the directional detections. Especially, it is expected to be efficient to distinguish isotropic distribution models from non-isotropic ones.

Summary:

Parallel IV / 108

Lepton Flavor Violating Radiative Decays in EW-Scale ν_R Model: An Update

Authors: Hung P. Q[1]; Trinh Le[2]; Tzu-Chiang Yuan[3]; Van Que Tran[4]

[1] *Department of Physics, University of Virginia, USA & Center for Theoretical and Computational Physics, Hue University College of Education, Hue, Vietnam.*

[2] *Department of Physics, University of Virginia, USA*

[3] *Institute of Physics, Academia Sinica, Taiwan & Physics Division, National Center for Theoretical Sciences, Hsinchu, Taiwan*

[4] *Department of Physics, National Taiwan Normal University, Taiwan*

Corresponding Author: apctranque@gmail.com

We perform an updated analysis for the one-loop induced lepton flavor violating radiative decays $l_i \to l_j\gamma$ in an extended mirror model. Mixing effects of the neutrinos and charged leptons constructed with a horizontal A_4 symmetry are also taken into account. Current experimental limit and projected sensitivity on the branching ratio of $\mu \to e\gamma$ are used to constrain the parameter

space of the model. Calculations of two related observables, the electric and magnetic dipole moments of the leptons, are included. Implications concerning the possible detection of mirror leptons at the LHC and the ILC are also discussed.

Summary:

Parallel IV / **228**

free time

Parallel IV / **215**

Recent Progress on Muon g-2 Experiment at Fermilab

Author: Liang Li[1]

[1] *Shanghai Jiao Tong University*

Corresponding Author: l.li@cern.ch

The muon anomalous magnetic moment is a fundamental quantity that has played an important role in the development of the Standard Model.It can be both measured and computed to very high precision, providing a sharp tool in testing the robustness of the SM and predictions by the theories of BSM physics. The previous measurement by the Brookhaven E821 experiment found a 3.6 standard deviation discrepancy from the predicted value. The Muon g-2 Experiment at Fermilab aims to achieve a factor of four improvement in measured precision with an upgraded apparatus, a reduced systematic uncertainty and about 20 times more data. The experiment is well on schedule to take first data in 2017.

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2017.

Parallel IV / **81**

The Mu2e Experiment at Fermilab

Author: ivano sarra[1]

[1] *infn*

Corresponding Author: ivano.sarra@lnf.infn.it

The Mu2e Experiment at Fermilab will search for coherent, neutrinoless conversion of muons into electrons in the field of a nucleus with a sensitivity improvement of a factor of 10,000 over previous experiments. Such a charged lepton flavor-violating reaction probes new physics at a scale inaccessible with direct searches at either present or planned high energy colliders. The experiment both complements and extends the current search for muon
decay to electron+gamma at MEG and searches for new physics at the LHC. We will present the physics motivation for Mu2e, the novel design of the muon beam line and the detector, and
the current status of the experiment.

Summary:

The Mu2e Experiment, physics motivation and current status

Parallel IV / 101

$\mu \to e$ Conversion in the Electroweak-scale Right-handed Neutrino Model

Authors: P.Q. Hung[1]; Trinh Le[1]; Tzu-Chiang Yuan[2]; Van Que Tran[3]

[1] *University of Virginia*

[2] *Academia Sinica, Taiwan*

[3] *National Taiwan Normal University*

Corresponding Author: ttl9ve@virginia.edu

Within the framework of the Electroweak-scale right-handed neutrino (EW-ν_R) model, we calculate the rate for $\mu \to e$ conversion with a particular aim at the sensitivities
of the upcoming experiments, Mu2e (6×10^{-17}) and COMET (3×10^{-17}). Our calculations show a direct relationship between the rate for $\mu \to e$ conversion and that for $\mu \to e\gamma$. Upon comparing the projected sensitivities with the present limit from SINDRUM II (6.1×10^{-13}) and including the upper bound on $\mu \to e\gamma$ (5.7×10^{-13}), we found that approximately only half of the allowed parameter space between the SINDRUM II limit and the sensitivities of Mu2e and COMET is available ($\sim 10^{-17} - 10^{-15}$).

Summary:

Parallel IV / 109

Studies of the rare decays B -> K* l+ l- and B -> K pi pi gamma and search for B+ -> K+ tau+ tau- at BABAR

Author: Abi Soffer[1]

[1] *Tel Aviv University (IL)*

Corresponding Author: abner.soffer@cern.ch

Flavour changing neutral current processes, such as B -> K(*)l+l- *where l = e+, mu+, tau+ are highly suppressed in the Standard Model (SM). These rare decays occur at lowest order via 1-loop diagrams, and contributions from virtual particles in the loop allow one to probe large mass scales at relatively low energies. We present here the most recent results based on the full BABAR data sample, collected at the energy of the Y(4S) resonance, which corresponds to 471 million BBbar pairs. In particular, the decays B -> K* l+l- (both charged and neutral modes) are studied using an angular analysis to extract the quantities A_FB and F_L, which are sensitive to potential effects of physics beyond the Standard

Model. Furthermore, the quantity P_2, which is subject to smaller theoretical uncertainties and is more sensitive to non-SM contributions, is extracted. We also present a search for the B+ -> K+ tau+ tau- decay. This search is performed on the recoil of a fully reconstructed B-meson decay from the decay of Y(4S) -> B+B-, by looking for activity compatible with B+ -> K+ tau+ tau- decay and leptonic decays of the two tau's in the rest of the event. Finally, we report the measurement of the CP asymmetry in the radiative decay B0->Ks0 pi- pi+ gamma, a quantity that is sensitive to possible processes where non-SM photon helicities are involved. The structure of the hadronic final state is studied using the isospin-related decay B+ ->K+ pi- pi+ gamma.

Summary:

Parallel IV / 130

DeeMe, a muon to electron conversion search experiment at J-PARC MLF

Author: Hiroaki Natori[1]

[1] *KEK*

Corresponding Author: hiroaki.natori@gmail.com

DeeMe is an experiment which aims to find a clear evidence of the existence of the new physics beyond the standard model by searching for one of the lepton flavor violating reactions, mu-e conversion at J-PARC MLF. The details of the experiment is presented in this talk.

Summary:

Parallel IV / 129

Searches for light new-physics particles with BaBar data

Co-author: Fabio Anulli [1]

[1] *Universita e INFN, Roma I (IT)*

Corresponding Author: livio.lanceri@ts.infn.it

We report on the latest searches for low mass states predicted in several New Physics models performed with the data collected by the BaBar detector at the PEP-II e+e- collider. In particular we search for a new muonic dark force mediated by a gauge boson (Z') coupling only to the second and third lepton families. The existence of the Z' boson is probed in e+e- -> mu+mu- Z', Z'-> mu+ mu- events. No significant signal is observed. Limits on dark-sector coupling constants are derived, improving the current constraints to the allowed parameter space. We also present a test of the existence of light scalar (A0) or vector (A') particles decaying into an invisible final state and produced in two-body processes Upsilon -> gamma A0, A0 -> invisible, and e+e- -> gamma A', A'-> invisible. Such particles appear in extensions of the Standard Model, such as the Next-to-Minimal Supersymmetric Standard Model, where a light CP-odd Higgs boson A0 naturally couples strongly to b-quarks. Vector states A'are predicted by "dark sector" models, where A'is a new U(1) gauge boson that interactions among dark matter particles and can kinetically mix with the Standard Model photon. The analysis, based on the BaBar dataset with a single-photon trigger collected in 2007-2008, sets significant constraints on the coupling of these states to electrons and b quarks.

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collected in 2007-2008, sets significant constraints on the coupling of
these states to electrons and b quarks.

Parallel IV / 139

Lepton flavor violation processes in the charged lepton sector in minimal lepton flavor violation models

Author: Nguyen Dinh Dinh[1]

[1] *Institute of Physics, Hanoi, Vietnam*

Corresponding Author: dndinh@iop.vast.vn

In this report, we study lepton flavor violation in some typical scenarios of minimal lepton flavor violation (MLFV). We introduce briefly the MLFV models in the three following scenarios: i, the Standard Model (SM) field content basing on lepton flavor group $G_{LF} = SU(3)_L \times SU(3)_{E_R}$; the see-saw type I field contents with three heavy right-handed neutrinos, and the lepton flavor group $G_{ELF} = SU(3)_L \times SU(3)_{E_R} \times SU(3)_{\nu_R} = G_{LF} \times SU(3)_{\nu_R}$, in cases: ii, $SU(3)_{\nu_R} \to O(3)_{\nu_R} \times \mathrm{CP}$; and iii, $SU(3)_L \times SU(3)_{\nu_R} \to SU(3)_{L+\nu_R}$. Then the rates of LFV processes, such as $\ell \to \ell' + \gamma$, $\mu - e$ conversion, and $\ell \to 3\ell'$ will be introduced and analyzed using the current neutrino oscillation experimental data.

Summary:

Parallel IV / 146

Neutral pion form factor measurement and Search for K+ to pi+ nunu at NA62

Author: Cristina Lazzeroni[1]

Co-author: Michal Zamkovsky [2]

[1] *University of Birmingham (GB)*

[2] *Charles University (CZ)*

Corresponding Author: michal.zamkovsky@cern.ch

The NA62 experiment at CERN SPS collected a large sample of charged kaon decays with a highly efficient trigger for decays into electrons in 2007 using the experimental setup of the earlier kaon experiment at CERN NA48/2. The kaon beam represents a source of tagged neutral pion decays in vacuum. A measurement of the electromagnetic transition form factor slope of the neutral pion in the time-like region from ˜1 million fully reconstructed pi0 Dalitz decay is presented. The limits on dark photon production in pi0 decays from NA48/2 are also reported. The K+->pi+nunu decay is one of the theoretically cleanest meson decay where to look for indirect effects of new physics complementary to LHC searches. The new experimental setup used by the NA62 experiment at CERN SPS since 2014 is designed to measure the branching ratio of this decay with 10% precision. NA62 took data with the new setup in pilot runs in 2014 and 2015 reaching the final designed beam intensity. The quality of data acquired in view of the final measurement will be presented.

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Parallel IV / **214**

$\mu^- e^- \to e^- e^-$ in muonic atoms

Author: Yuichi UESAKA[1]

Co-authors: Joe SATO [2]; Masato YAMANAKA [3]; Toru SATO [1]; Yoshitaka KUNO [1]

[1] *Osaka University*

[2] *Saitama University*

[3] *Nagoya University*

Corresponding Author: uesaka@kern.phys.sci.osaka-u.ac.jp

The charged lepton flavor violating (CLFV) processes of $\mu^- e^- \to e^- e^-$ decay by four Fermi contact interactions in a muonic atom for various atoms are investigated. The wave functions of bound and scattering state leptons are properly treated by solving Dirac equations with Coulomb interaction of the finite nuclear charge distributions. This new effect contributes significantly in particular for heavier atoms, where the obtained decay rate is about one order of magnitude larger than the previous estimation for ^{208}Pb. We find that, as the atomic number Z increases, the $\mu^- e^- \to e^- e^-$ decay rates increase more rapidly than the result of the previous work of Z^3, suggesting this decay as one of the promising processes to search for CLFV interaction.

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promising processes to search for CLFV interaction.

Parallel IV / 217

The COMET experiment

Author: Phillip Litchfield[1]

[1] *UCL*

Corresponding Author: p.litchfield@ucl.ac.uk

The COMET experiment intends to search for the lepton flavor-violating conversion of a muon to electron while in the orbit of an atomic nucleus. The process is not forbidden by any symmetry of the Standard Model, but remains extremely suppressed even when flavor-mixing neutrino masses are introduced, due to the relative smallness of these masses. Because this suppression is accidental in the Standard Model, the rate of such conversion is expected to be greatly enhanced across a very broad range of new physics scenarios.

COMET makes use of the J-PARC Main Ring accelerator and novel curved-solenoid focussing elements to obtain a very intense pulsed muon beam, and this gives the experiment the ability to observe a signal four orders of magnitude weaker than current limits. Because the increase in sensitivity is so dramatic, the experiment will run in phases, with the first phase using fewer focussing elements in order to obtain data on the secondary beam composition. This "Phase-I" of the project is nevertheless capable of a factor 100 improvement over the current limit. Both phases will be described, including progress in construction of the Phase-I experiment.

Summary:

Parallel V / 229

free time

Parallel V / 232

Dirac Operator in Discretized Kaluza-Klein Theory

Authors: Aiviet Nguyen[1]; Kameshwar C Wali[2]

[1] *Information Technology Institute, VNU*

[2] *Syracuse University*

Corresponding Author: aivietn@gmail.com

The coupling of gravity to chiral quark-leptons is investigated in the Discretized Kaluza-Klein theory with a new Dirac operator and a new wedge product. It is reduced to the couplings of chiral quark-spinors to the ordinary gravity and the gauge fields together with new interaction terms.

Summary:

Parallel V / 85

Polonyi Inflation

Author: Kai Schmitz[1]

[1] *Max Planck Institute for Nuclear Physics (MPIK)*

Corresponding Author: kai.schmitz@mpi-hd.mpg.de

In this talk, I will report on my latest work together with Tsutomu Yanagida on an interesting possibility to unify the dynamics of spontaneous supersymmetry breaking and cosmic inflation. Our model is based on strong gauge dynamics, explains the high supersymmetry breaking scale, and also provides an answer to the question "why is there such a thing as cosmic inflation in the first place".

Summary:

Spontaneously broken supersymmetry (SUSY) and a vanishingly small cosmological constant imply that R symmetry must be spontaneously broken at low energies. Based on this observation, we suppose that, in the sector responsible for low-energy R symmetry breaking, a discrete R symmetry remains preserved at high energies and only becomes dynamically broken at relatively late times in the cosmological evolution, i.e., after the dynamical breaking of SUSY. Prior to R symmetry breaking, the Universe is then bound to be in a quasi-de Sitter phase—which offers a dynamical explanation for the occurrence of cosmic inflation. This scenario yields a new perspective on the interplay between SUSY breaking and inflation, which neatly fits into the paradigm of high-scale SUSY: inflation is driven by the SUSY-breaking vacuum energy density, while the chiral field responsible for SUSY breaking, the Polonyi field, serves as the inflaton. Because R symmetry is broken only after inflation, slow-roll inflation is not spoiled by otherwise dangerous gravitational corrections in supergravity. We illustrate our idea by means of a concrete example, in which both SUSY and R symmetry are broken by strong gauge dynamics and in which late-time R symmetry breaking is triggered by a small inflaton field value. In this model, the scales of inflation and SUSY breaking are unified; the inflationary predictions are similar to those of F-term hybrid inflation in supergravity; reheating proceeds via gravitino decay at temperatures consistent with thermal leptogenesis; and the sparticle mass spectrum follows from pure gravity mediation. Dark matter consists of thermally produced winos with a mass in the TeV range.

Parallel V / 123

Resurrecting Quartic and Quadratic inflaton potentials in two-field inflationary model

Co-authors: Gaetano Lambiase [1]; Girish Chakravarty [2]; Subhendra Mohanty [2]

[1] *Universita di Salerno*

[2] *PRL, Ahmedabad*

Corresponding Authors: suratna@iitk.ac.in, suratna.das.2007@gmail.com

After the release of the PLANCK data, it is evident that inflationary paradigm has stood the test of time. Even though, it is difficult to realise inflationary paradigm in a particle physics model as the present observations have ruled out the simplest quartic and quadratic inflationary potentials, which generically arise in particle physics. We would show that such simplest inflationary potentials can evade discrepancies with observations, if the inflaton field is assisted by another scalar during inflation. Moreover, unlike other multifiled models, our model yields no isocurvature perturbations and negligible non-Gaussianity, making it more compatible with the present data. Above all, our model can also be relaised in the framework of SUGRA.

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Parallel V / **67**

Families-unified GUTs from superstring

Author: Jihn E. Kim[1]

[1] *Kyung Hee University*

Corresponding Author: jihnekim@gmail.com

From compactification of E8xE8 heterotic string, I attempt to construct an extended GUT where families are unified. There appears an anti-SU(7) GUT group from which weak CP is calculated under the assumption of only one CP phase in the theory.

Summary:

I will discuss the unification of families from compactification of heterotic string. There appears an anti-SU(7) GUT group from this study. Also, the weak CP phase is calculated under the assumption of only one CP phase in the theory.

Parallel V / **86**

Hawking fluxes and Anomalies in the Rotating Regular Black Holes with the Time-Delay

Author: Shingo Takeuchi[1]

[1] *Institute for Fundamental Study, Naresuan University*

Corresponding Author: shingo.porttable@gmail.com

We are going to calculate the flow of the angular momentum and flux of the Hawking radiation in the rotating regular black hole with the time-delay proposed in arXiv:1510.08828, based on the anomaly cancellation. We first try to reduce the field theories to the infinite two-dimensional massless free models in which the anomaly cancellation method is possible, in the three metrics in arXiv:1510.08828. We demonstrate that the two of them can be reduced. We perform the calculation in these two metrics, and obtain the flow of the angular momentum and flux of the Hawking radiation in these two metrics. Our result involves the three effects:˜the quantum gravity effect regularizing the gravity sources of the black holes, the black hole rotation, and the time-delay. Hence our result could be considered to correspond to a more realistic Hawking radiations. (This study has been submitted to arXiv on 15 March, where the given arXiv number is arXiv:1603.04159. This study is now under review in an international journal, Classical and Quantum Gravity.)

Summary:

Parallel V / 74

Holographic polytropic reconstruction model of f(T) gravity

Author: Surajit Chattopadhyay[None]

Corresponding Author: surajitchatto@outlook.com

The accelerated expansion of the universe is strongly manifested after the discovery of unexpected reduction in the detected energy fluxes coming from SNe Ia. Other observational data like CMBR, LSS and galaxy redshift surveys also provide evidences in this favor. These observations propose a mysterious form of force, referred as dark energy (DE), which takes part in the expansion phenomenon and dominates overall energy density of the universe.

Physical origin of DE is one of the largest mysteries not only in cosmology but also in fundamental physics. Holographic reconstruction of modified gravity model is a very active area of research in cosmology. Unfortunately, nature of DE is still not known and probably that has motivated theoretical physicists towards development of various candidates of DE and recently geometric DE or modified gravity has been proposed as a second approach to account for the late time acceleration of the universe. In literature, mostly reconstructed work has been done with polytropic EoS, family of holographic DE models, family of Chaplygin gas, scalar field models in general relativity as well as modified theories of gravity (in framework of $f(T)$ gravity).

The polytropic gas model can explain the EoS of degenerate white dwarfs, neutron stars and also the EoS of main sequence stars. The present paper reports a study on the cosmological consequences arising from reconstructing $f(T)$ gravity through new holographic-polytropic dark energy. We assume two approaches, namely a particular form of Hubble parameter H and a solution for $f(T)$. We obtain the deceleration parameter, effective equation of state as well as torsion equation of state parameters from total density and pressure in both cases. It is interesting to mention here that the deceleration and torsion equation of state represent transition from deceleration to acceleration phase. We study the statefinder parameters under both approaches which result that statefinder trajectories are found to attain ΛCDM point. The comparison with observational data represents consistent results. Also, we discuss the stability of reconstructed models through squared speed of sound which represents stability in late times.

Summary:

Parallel V / 102

Leptogenesis in $E_6 \times U(1)_A$ SUSY GUT model

Author: Masato Yamanaka[1]

Co-authors: Mao Takegawa [2]; Nobuhiro Maekawa [2]; Takuya Ishihara [2]

[1] *Kyoto Sangyo University*

[2] *Nagoya University*

Corresponding Author: masato.yamanaka@cc.kyoto-su.ac.jp

The essential point is that the mass of the lightest right-handed neutrino can be enhanced in the model because it has a lot of mass terms whose mass parameters are predicted to be the same order of magnitude which is smaller than 10^8 GeV. We show that O(10) enhancement for the lightest right-handed neutrino mass is sufficient for the observed baryon asymmetry. Note that such mass enhancements do not change the predictions of neutrino masses and mixings at the low energy scale in the E_6 model which has six right-handed neutrinos. In the calculation, we include the effects of supersymmetry and flavor in final states of the right-handed neutrino decay. We show that the effect of supersymmetry is quite important even in the strong washout regime when the effect of flavor is included. This is because the washout effects on the asymmetries both of the muon and the electron become weaker than that of the tau asymmetry.

Summary:

We study the thermal leptogenesis in the $E_6 \times U(1)_A$ SUSY GUT model in which realistic masses and mixings of quarks and leptons can be realized. We show that the sufficient baryon number can be produced by the leptogenesis in the model, in which the mass parameter of the lightest right-handed neutrino is predicted to be smaller than
10^8 GeV.

Parallel V / 79

Non-minimally coupled inflation with a pre-inflation anamorphic contracting era; 750 GeV resonance as the inflaton: Unitarity violation and why the resonance is a real singlet scalar

Author: John McDonald[1]

[1] *Lancaster University*

Corresponding Author: j.mcdonald@lancaster.ac.uk

Inflation due to a non-minimally coupled scalar field is in good agreement with the observed value of spectral index and constraints on the tensor-to-scalar ratio. Here we explore the possibility that non-minimally coupled inflation represents the late stage of a Universe which emerges from an early contracting era. We present a model in which the Universe smoothly transitions from an anamorphic contracting era to late-time non-minimally coupled inflation without encountering a singular bounce. This corresponds to a continuous expansion in the Einstein frame throughout. We show that the anamorphic contracting era is able to provide the smooth superhorizon initial conditions necessary for subsequent non-minimally coupled inflation to occur. The model predicts corrections to the non-minimal coupling, kinetic term and potential of non-minimally coupled inflation which can observably increase the spectral index relative to its non-minimally coupled inflation prediction.

The 750 GeV resonance observed by ATLAS and CMS may be explained by a gauge singlet scalar. This would provide an ideal candidate for a gauge singlet scalar alternative to Higgs Inflation, S-inflation. Here we discuss the relevant results of S-inflation in the context of the 750 GeV resonance. In particular, we show that a singlet scalar, if it is real, has a major advantage over the Higgs boson with regard to unitarity violation during inflation. This is because it is possible to restrict the large non-minimal coupling required for inflation, ξ~105, to the real singlet scalar, with all other scalars having ξ~1. In this case the scale of unitarity violation Λ is much larger than the inflaton field during inflation. This protects the inflaton effective potential from modification by the new physics or strong coupling which is necessary to restore unitarity, which would otherwise invalidate the perturbative effective potential based on Standard Model physics. This is in contrast to the case of Higgs Inflation or models based on complex singlet scalars, where the unitarity violation scale during inflation is less than or of the order of the inflaton field. Therefore if the 750 GeV resonance is the inflaton, it must be a non-minimally coupled real singlet scalar.

Summary:

Parallel V / 82

On higher dimensional nonlinear massive gravity

Author: Tuan Do[1]

[1] *Vietnam National University, Hanoi*

Corresponding Author: tuanqdo@vnu.edu.vn

We will present main results of our recent study on higher dimensional scenarios of a ghost-free nonlinear massive gravity proposed by de Rham, Gabadadze, and Tolley (dRGT). In particular, a useful method, which is based on the Cayley-Hamilton theorem, to construct higher dimensional massive graviton terms will be presented. The constant-like behavior of massive graviton terms of five-dimensional dRGT theory will be shown to be valid for a number of physical metrics compatible with fiducial ones such as the Friedmann-Lemaitre-Robertson-Walker, Bianchi type I, and Schwarzschild-Tangherlini-(A)dS metrics. Finally, the corresponding cosmological solutions for the five-dimensional dRGT theory with effective cosmological constants derived from massive graviton terms will be mentioned.

Summary:

Parallel V / 137

Three-generation models from SO(32) heterotic string theory

Author: Hajime Otsuka[None]

Co-authors: Hiroyuki Abe [1]; Takuya Tatsuishi [2]; Tatsuo Kobayashi [2]; Yasufumi Takano [2]

[1] *Waseda University*

[2] *Hokkaido University*

Corresponding Author: h.otsuka@aoni.waseda.jp

In this talk, we show the concrete embeddings of the standard model gauge groups into SO(32) gauge group in terms of the multiple U(1) fluxes. The correct matter contents of the standard model are then derived from the adjoint and vector representations of SO(12) given by the subgroup of SO(32). Since the number of generations corresponds to the number of U(1) fluxes, we search for the desired matter contents of the standard model satisfying the $U(1)_Y$ massless conditions as well as the SUSY conditions. Our models satisfy the typical theoretical constraints which are required from the consistency of heterotic string theory.
Finally, we discuss quark masses and mixing angles in $SU(3)_f$ and $\Delta(27)$ models.

Summary:

We search for realistic supersymmetric standard-like models from SO(32) heterotic string theory on factorizable tori with multiple magnetic fluxes. Three chiral ganerations of quarks and leptons are derived from the adjoint and vector representations of SO(12) gauge groups embedded in SO(32) adjoint representation. Massless spectra of our models also include Higgs fields, which have desired Yukawa couplings to quarks and leptons at the tree-level.
In models with the flavor symmetries $SU(3)_f$ and $\Delta(27)$, we can realize the realistic quark masses and mixing angles.

Parallel V / 141

DBI action of real linear superfield in 4D N=1 conformal supergravity

Author: Shuntaro Aoki[1]

Co-author: Yusuke Yamada [2]

[1] *Waseda University*

[2] *Waseda university*

Corresponding Author: shun-soccer@akane.waseda.jp

The Dirac-Born-Infeld (DBI) action play important roles in the context of string theory. In the string theory, an effective action of D-brane is described by a DBI-type action, which consists of Maxwell terms as well as the ones of scalar fields in general. From a phenomenological and theoretical viewpoint, the embedding of the DBI action into supersymmetry (SUSY) or supergravity (SUGRA) is interesting. However, in 4D N = 1 SUGRA,
there has never been such extension of the DBI action for scalar fields.
In this talk, we discuss the construction of the DBI action for scalar fields, using a real linear multiplet in 4D N = 1 supergravity. Based on conformal supergravity, we derive the general condition under which the DBI action can be realized, and show that
it can be constructed in the new minimal supergravity. We also generalize it to the matter coupled system.

Summary:

Parallel V / 121

Magnetized orbifold models of dynamical supersymmetry breaking

Author: Keigo SUMITA[None]

Co-authors: Hiroyuki Abe [1]; Tatsuo Kobayashi [2]

[1] *Waseda University*

[2] *Hokkaido University*

Corresponding Author: k.sumita@aoni.waseda.jp

Magnetic fluxes in extra dimensional space can be an origin of the flavor structure of the standard model. In particular, in higher-dimensional supersymmetric Yang-Mills (SYM) theories compactified on magnetized orbifolds, several MSSM-like models were constructed successfully.
In this work, we derive dynamical supersymmetry breaking models from a single SYM theory compactified on magnetized orbifolds to combine with the MSSM-like models mentioned above. In magnetized orbifold models, essential structure of dynamical supersymmetry breaking mechanism, such as, field contents, their couplings and the number of flavors of SU(N) gauge theory, is completely determined by the structure of extra dimensional space. We research configurations of the magnetic fluxes and orbifold projections in a systematic way. As the result, we found several suitable configurations to generate the dynamical supersymmetry breaking. Furthermore, in some of the obtained configurations, orbifold projections eliminate all of extra massless modes which will cause problems in phenomenology of particle physics and cosmology.
We also discuss its association with other sectors, such as, the MSSM sector and moduli stabilization mechanisms.

Summary:

Parallel V / 127

Gauge Coupling Unification in Gauge-Higgs Grand Unification

Author: Naoki Yamatsu[1]

[1] *Kyoto Sangyo University*

Corresponding Author: yamatsu@cc.kyoto-su.ac.jp

Recently an SO(11) gauge-Higgs grand unified theory (GHGUT) in 5D Randall-Sundrum warped space was proposed in PTEP(2015)111B01(arXiv:1504.03817). In this framework, the 4D SM bosons and fermions are naturally realized by the SO(11) bulk gauge boson and SO(11) spinor bulk fermions, respectively. GHGUT leads to gauge coupling unification, so it is inevitable to discuss the renormalization group evolution for SM gauge coupling constants because the value of the Weinberg angle from GUT prediction does not agree with its low-energy observation data. In this talk, I will discuss SM gauge coupling unification in the SO(11) GHGUT by using 4D renormalization group equations. This talk is based on PTEP(2016)043B02(arXiv:1512.05559).

Summary:

Parallel V / 156

Gauge invariance in the actual calculation of a bubble nucleation rate

Authors: Motoi Endo[1]; Takeo Moroi[2]; Yutaro Shoji[3]; mihoko nojiri[1]

[1] *KEK*

[2] *The University of Tokyo*

[3] *ICRR, University of Tokyo*

Corresponding Author: yshoji.hep@gmail.com

To determine bubble nucleation rates precisely, we need to evaluate functional determinants around the bounce background. In gauge theories, there appears a mixing between the would-be NG boson and the gauge boson, and it becomes quite difficult to see the gauge dependence of the functional determinant. Though the gauge independence of the effective action is proven by Nielsen at all orders, it is still unclear that the gauge dependence cancels out within the one-loop level. Furthermore, there can appear gauge zero modes, which correspond to the breaking of the global part of the gauge symmetry. In the actual calculation, we need to regularize the zero modes in a gauge invariant way.

In this talk, we prove the gauge invariance of the functional determinant in a non-trivial background, and discuss a way to regularize the gauge zero modes.

Summary:

Parallel V / 157

General Pole Inflation and Inflationary Attractors

Author: Takahiro TERADA[None]

Corresponding Author: takahiro.terada@apctp.org

A reformulation of inflationary model analyses appeared recently, in which inflationary observables are determined by the structure of a pole in the inflaton kinetic term rather than the shape of the inflaton potential.
This is called pole inflation, and it is a generalization of α-attractors and ζ-attractors.
The predicted values of inflationary observables are universal in the attractor limit in the sense that they do not depend on the details of the original potential.

We comprehensively study this framework with an arbitrary order of the pole taking into account possible additional poles in the kinetic term or in the potential.
Depending on the setup, the canonical potential becomes the form of hilltop or plateau models, variants of natural inflation, power-law inflation, or monomial/polynomial chaotic inflation.
The boundary of the effective field theory is discussed, which motivates the study of additional poles.
We demonstrate attractor behaviors of these models and compute corrections from the additional poles to the inflationary observables.
Realization of these new attractor models in supergravity is briefly discussed.

Summary:

A reformulation of inflationary model analyses appeared recently, in which inflationary observables are determined by the structure of a pole in the inflaton kinetic term rather than the shape of the inflaton potential.
We comprehensively study this framework with an arbitrary order of the pole taking into account possible additional poles in the kinetic term or in the potential.
Depending on the setup, the canonical potential becomes the form of hilltop or plateau models, variants of natural inflation, power-law inflation, or monomial/polynomial chaotic inflation.
We demonstrate attractor behaviors of these models and compute corrections from the additional poles to the inflationary observables.

Parallel V / 159

AdS/dS gauge/gravity correspondence

Author: Dimitrios Giataganas[1]

Co-author: chong-sun chu

[1] *NCTS*

Corresponding Author: dimitrios.giataganas@gmail.com

We propose and study a holographic dual of the type IIB superstring theory of AdS_5xSˆ5 in terms of the N=4 superconformal Yang-Mills theory on dS_4. We review the bulk to boundary formalism to evaluate the boundary correlation functions. Then we present several non-local observables related to heavy quarks in the dual theory on dS_4.

Summary:

Parallel V / 207

Probing classically conformal B-L model with gravitational waves

Author: Ryusuke Jinno[1]

[1] *High Energy Accelerator Research Organization (KEK)*

Corresponding Author: jinno@post.kek.jp

We study the cosmological history of the classical conformal B–L gauge extension of the standard model, in which the physical scales are generated via the Coleman-Weinberg-type symmetry breaking. Especially, we consider the thermal phase transition of the U(1)B–L symmetry in the early universe and resulting gravitational-wave production. Due to the classical conformal invariance, the phase transition tends to be a first-order one with ultra-supercooling, which enhances the strength of the produced gravitational waves. We show that, requiring (1) U(1)B–L is broken after the reheating, (2) the B–L gauge coupling does not blow up below the Planck scale, (3) the thermal phase transition completes in almost all the patches in the universe, the gravitational wave spectrum can be as large as Ω_{GW}~10^{−8} at the frequency f~0.01-1Hz for some model parameters, and a vast parameter region can be tested by future interferometer experiments such as eLISA, LISA, BBO and DECIGO.

Summary:

We study the gravitational wave production in so-called “classically-conformal” type models at the time of cosmic phase transition, taking the classically-conformal B-L model as an example.

Parallel V / 209

Chiral Primordial GWs due to the production of non-Abelian gauge field

Author: Ippei Obata[1]

Co-author: Jiro Soda [2]

[1] *Kyoto University*

[2] *Kobe University, Japan*

Corresponding Author: obata@tap.scphys.kyoto-u.ac.jp

It is known that chiral primordial gravitational waves (GWs) are provided due to the strong interaction of gauge fields to axions during inflation. Interestingly, in the case of non-Abelian gauge fields, they can produce chiral GWs at linear level. In this talk, we explain the mechanism of generating such chiral primordial GWs and discuss their detectability in future observations.

Summary:

Parallel V / 206

Metastable Electroweak Vacuum and Chaotic Inflation

Author: Kyohei Mukaida[1]

Co-authors: Kazunori Nakayama [2]; Masahiro Kawasaki [3]; T.Tsutomu Yanagida [1]; Yohei Ema [2]

[1] *Kavli IPMU*

[2] *University of Tokyo*

[3] *ICRR*

Corresponding Author: kyohei.mukaida@ipmu.jp

We revisit the compatibility between the chaotic inflation, which provides a natural solution to the initial condition problem, and the metastable electroweak vacuum, which is suggested by the results of LHC and the current mass measurements of top quark and Higgs boson. It is known that the chaotic inflation poses a threat to the stability of the electroweak vacuum because it easily generates large Higgs fluctuations during inflation and triggers the catastrophic vacuum decay. A simple way to avoid this problem is to introduce a small coupling between the Higgs and inflaton, like a non-minimal coupling of Higgs.

First, however, I will show that this coupling threats the stability of the vacuum after inflation. This is because it oscillates violently with a large amplitude of inflaton,
and can produce large Higgs fluctuations.

Then, I will discuss a simple cosmological scenario in which the vacuum is always stabilized during chaotic inflation, preheating and after that. Interestingly, it naturally predicts formation of primordial black holes. I will discuss these PBHs as a dominant component of dark matter.

This is based on 1602.00483 in collaboration with Y. Ema and K. Nakayama;
and 1605.04974 with M. Kawasaki and T. T. Yanagida.

Summary:

Parallel V / **208**

Analytic gravitational wave spectrum from bubble collisions

Author: Ryusuke Jinno[1]

[1] *KEK*

Corresponding Author: jinno0121@gmail.com

We consider gravitational wave production by bubble collisions during a cosmological first-order phase transition. In the literature, such spectra have been estimated by simulating the bubble dynamics, under so-called thin-wall and envelope approximations in a flat background metric. However, we show that, within these assumptions, the gravitational wave spectrum can be estimated in an analytic way. Our estimation is based on the observation that the two-point correlator of the energy-momentum tensor ⟨T(x)T(y)⟩ can be expressed analytically under these assumptions. Though the final expressions for the spectrum contain a few integrations that cannot be calculated explicitly, we can easily estimate it numerically. As a result, it is found that the most of the contributions to the spectrum come from single-bubble contribution to the correlator, and in addition the fall-off of the spectrum at high frequencies is found to be proportional to f^{−1}. We also provide fitting formulae for the spectrum.

Summary:

Gravitational waves from bubble collisions can be a probe to a physics beyond the standard model which triggers cosmic phase transition. The gravitational-wave spectrum from bubble collisions has been calculated in numerical simulations in the literature with a couple of reasonable assumptions and approximations. We show that this spectrum can be derived analytically in the same setup as in such numerical-simulation literature, without statistical errors. This work helps to fix the theoretical prediction for the GW spectrum from bubble collisions.

Parallel V / **165**

Entanglement Dynamics of Detectors in an Einstein Cylinder

Author: Chung-Hsien Chou[1]

Co-authors: Bei-Lok Hu [2]; Shih-Yuin Lin [3]

[1] *Department of Physics, National Cheng Kung University*

[2] *Maryland Center for Fundamental Physics and Joint Quantum Institute, University of Maryland*

[3] *Department of Physics, National Changhua University of Education*

Corresponding Author: chouchunghsien@gmail.com

We investigates how nontrivial topology affects the entanglement dynamics between a detector and a quantum field and between two detectors mediated by a quantum field. Nontrivial topology refers to both that of the \textit{base space}
and that of the \textit{bundle}. Using a derivative-coupling Unruh-DeWitt-like detector model interacting with a quantum scalar field in an Einstein cylinder
$\mathbf{S}^1$ (space) $\times\mathbf{R}_1$ (time), we see the beating behaviors in the dynamics of the detector-field entanglement
and the detector-detector entanglement, which distinguish from the results in the non-compact (1+1) dimensional Minkowski space.
The beat patterns of entanglement dynamics in an untwisted and twisted fields with the same parameter values are different simply because
of different spectrum of the eigen-modes. In terms of the physically measurable momentum of the detectors, we find that the contribution
by the zero mode in a normal field to entanglement dynamics has no qualitative difference from those by the nonzero modes.

Summary:

Parallel V / 213

O(N) scalar field model in de Sitter space: beyond the leading IR approximation

Author: Diana Laura LOPEZ NACIR[1]

[1] *CERN*

Corresponding Author: diana.laura.lopez.nacir@cern.ch

Quantum field theory on curved space-times is a very powerful framework for the study of quantum phenomena in situations where gravitation itself can be treated classically. Of special interest is the study of interacting quantum fields in de Sitter space-time, where corrections computed using the standard perturbative expansion are plagued by contributions that secularly grow with time and/or infrared divergences. This has motivated the consideration of alternative techniques. In this talk I will summarize recent work on this topic in relation to the development of non-perturbative methods to compute correlation functions in a systematic way.

Summary:

Parallel VI / 160

Adiabaticity and gravity theory independent conservation laws for cosmological perturbations

Author: Antonio Enea Romano[1]

[1] *UDEA/YITP*

Corresponding Author: aer@phys.ntu.edu.tw

Based on an article Published in Phys.Lett. B755 (2016) 464-468, in collaboration with Prof Misao Sasaki. director of the Yukawa Institute for Theoretical Physics(YITP), in Kyoto , Japan.

Summary:

We carefully study the implications of adiabaticity for the behavior of cosmological perturbations. There are essentially three similar but different definitions of non-adiabaticity: one is appropriate for a thermodynamic fluid δPnad, another is for a general matter field δPc,nad, and the last one is valid only on superhorizon scales. The first two definitions coincide if c2s=c2w where cs is the propagation speed of the perturbation, while c2w=P˙/ρ˙. Assuming the adiabaticity in the general sense, δPc,nad=0, we derive a relation between the lapse function in the comoving sli\-cing Ac and δPnad valid for arbitrary matter field in any theory of gravity, by using only momentum conservation. The relation implies that as long as cs≠cw, the uniform density, comoving and the proper-time slicings coincide approximately for any gravity theory and for any matter field if δPnad=0 approximately. In the case of general relativity this gives the equivalence between the comoving curvature perturbation Rc and the uniform density curvature perturbation ζ on superhorizon scales, and their conservation.
We then consider an example in which cw=cs, where δPnad=δPc,nad=0 exactly, but the equivalence between Rc and ζ no longer holds. Namely we consider the so-called ultra slow-roll inflation. In this case both Rc and ζ are not conserved. In particular, as for ζ, we find that it is crucial to take into account the next-to-leading order term in ζ's spatial gradient expansion to show its non-conservation, even on superhorizon scales. This is an example of the fact that adiabaticity (in the thermodynamic sense) is not always enough to ensure the conservation of Rc or ζ.

Parallel VI / 230

free time

Parallel VI / 88

Constraints on cosmological viscosity from GW150914 observation

Author: Gaurav Goswami[1]

Co-authors: A.R. Prasanna [2]; Subhendra Mohanty [2]

[1] *Ahmedabad University*

[2] *Physical Research Laboratory*

Corresponding Author: gaurav299792458@gmail.com

It has been shown that gravitational waves propagate through ideal fluids without experiencing any dispersion or dissipation. However, if the medium has a non-zero shear viscosity, gravitational waves will be dissipated at a rate proportional to Gη. We test Dark Matter and Dark Energy models with non-zero shear viscosity by calculating the dissipation of GW150914 which propagates over a distance of 410 Mpc through the dissipative fluid and comparing the data with the theoretical prediction. We put an upper bound on the shear viscosity of the cosmological fluid as $< 10^9$ Pa sec which is close to the critical viscosity of fluids at which the viscous pressure becomes significant for the dynamics of the Universe. We show that future observations of gravitational waves at LIGO have the potential of detecting any possible viscosity of Dark Matter and Dark Energy. Finally, we

comment on how this could be related to a lower bound on the self-interaction cross-section of Dark Matter.

Summary:

Parallel VI / **142**

A non-perturbative analysis of the cosmological constant problem

Author: Babar Qureshi[1]

[1] *Dept. of Physics, School of Science and Engineering, LUMS*

Corresponding Author: babar.a.qureshi@gmail.com

Conventional wisdom relates the vacuum energy arising from the zero point fluctuations of quantum fields with the cosmological constant which is a parameter in Eidnstien's field equations. The basis of this relation is in the semi-classical approximation where gravity is treated classically. However, as is well known, the effective cosmological constant generated by the zero-point fluctuations, even with a TeV scale cut-off, is many orders of magnitudes higher than the observed value.

We perform a non-perturbative analysis of the problem treating gravity and matter both quantum mechanically in a homogenous and isotropic setting. A deep connection between choice of time gauge and energy density of the universe is found. In the volume time gauge, we find that the relation between the ground state energy of the universe and the cosmological constant is not linear and depends explicitly on time. The ground state energy becomes small at later times even after summation over zero-point fluctuations. The talk is based on work published in PRL:

http://journals.aps.org/prl/abstract/10.1103/PhysRevLett.116.061302

Summary:

Parallel VI / **161**

Can Brans-Dicke theory with Λ>0 describe stars?

Author: Antonio Enea Romano[1]

Co-author: Theodoros Tomaras [2]

[1] *UDEA/YITP*

[2] *University of Crete (GR)*

Corresponding Author: aer@phys.ntu.edu.tw

Partially based on Phys.Rev.Lett. 115 (2015) no.18, 181104, in collaboration with Sourav Bhattacharya, Konstantinos F. Dialektopoulos, Antonio Enea Romano, Theodore N. Tomaras.

Summary:

A step-by-step approach is followed to study cosmic structures in the context of Brans-Dicke theory with positive cosmological constant Λ and parameter ω. First, it is shown that regular stationary black-hole solutions not only have constant Brans-Dicke field ϕ, but can exist only for ω=∞, which forces the theory to coincide with the General Relativity. Generalizations of the theory in order to evade this black-hole no-hair theorem are presented. It is also shown that in the absence of a stationary cosmological

event horizon in the asymptotic region, a stationary black hole horizon can support a non-trivial Brans-Dicke hair. Even more importantly, it is shown next, that the presence of a stationary cosmological event horizon rules out any regular stationary solution, appropriate for the description of a star. Thus, to describe a star one has to assume that there is no such stationary horizon in the faraway asymptotic region. Under this implicit assumption generic spherical cosmic structures are studied perturbatively and is shown that only for ω>0 or ω⊠−5 their predicted maximum sizes are consistent with observations. We also point out how, many of the conclusions of this work differ qualitatively from the Λ=0 spacetimes.

Parallel VI / 210

Cosmology with Democratic Initial Conditions

Author: James Unwin[1]

[1] *University of Illinois*

Corresponding Author: james.a.unwin@gmail.com

WIMP Dark Matter generally assumes the Standard Model and Dark Matter form a single thermal bath at early time, with the Dark Matter relic density set by interactions between these two populations. Arguably, a more compelling assumption is that Dark Matter is not part of the Standard Model sector. Even if there are decoupled dark sectors, then it is a natural expectation that the visible and dark sectors should be democratically reheated after inflation. At late time the Dark Matter abundance must be comparable to the baryon abundance, and it is interesting to investigate how to recover Standard Cosmology from these democratic initial conditions. If the Dark Matter is decoupled from the visible sector and does not undergo freeze-out, then without a large injection of entropy to the Standard Model, the Dark Matter will typically carry too much entropy. We ask what it takes for this scenario to be compatible with observations and arrive at a novel picture of dark matter with several interesting consequences.

Summary:

Parallel VI / 211

The Origin of the hot Big Bang from the Standard Model Higgs

Author: Daniel G. Figueroa[1]

[1] *CERN*

Corresponding Author: daniel.figueroa@cern.ch

Under general circumstances, the Standard Model Higgs is excited in the form of a condensate during or towards the end of inflation. The Higgs condensate is then forced to decay afterwards —due to non-perturbative effects —into the rest of the SM species. I will present the cosmological implications of this primordial decay, quantifying the necessary conditions to achieve a successful mechanism for 'reheating'the Universe into the SM. If there is enough time, I will also discuss the implications of all this for primordial gravitational waves.

Summary:

Parallel VI / **219**

Constraints on preinflation fluctuations in a nearly flat open $\Lambda_{\rm CDM}$ cosmology

Author: Lan NGUYEN[1]

[1] *Hanoi National University of Education*

Corresponding Author: nquynhlan@hnue.edu.vn

We analyze constraints on parameters characterizing the pre-inflating universe in an open inflation model with a present slightly open $\Lambda_{\rm CDM}$ universe. We employ an analytic model to show that for a broad class of inflation-generating effective potentials, the simple requirement that some fraction of the observed dipole moment represents a pre-inflation isocurvature fluctuation allows one to set upper and lower limits on the magnitude and wavelength scale of preinflation fluctuations in the inflaton field, and the curvature of the preinflation universe, as a function of the fraction of the total initial energy density in the inflaton field as inflation begins. We estimate that if the preinflation contribution to the current Cosmic Microwave Background (CMB) dipole is near the upper limit set by the Planck Collaboration then the current constraints on $\Lambda_{\rm CDM}$ cosmological parameters allow for the possibility of a significantly open $\Omega_i < 0.4$ preinflating universe for a broad range of the fraction of the total energy in the inflaton field at the onset of inflation. This limit to Ω_i is even smaller if a larger dark-flow tilt is allowed.

Summary:

We analyze constraints on parameters characterizing the pre-inflating universe in an open inflation model with a present slightly open ΛCDM universe. We employ an analytic model to show that for a broad class of inflation-generating effective potentials, the simple requirement that some fraction of the observed dipole moment represents a pre-inflation isocurvature fluctuation allows one to set upper and lower limits on the magnitude and wavelength scale of preinflation fluctuations in the inflaton field, and the curvature of the preinflation universe, as a function of the fraction of the total initial energy density in the inflaton field as inflation begins. We estimate that if the preinflation contribution to the current Cosmic Microwave Background (CMB) dipole is near the upper limit set by the Planck Collaboration then the current constraints on ΛCDM cosmological parameters allow for the possibility of a significantly open Ωi < 0.4 preinflating universe for a broad range of the fraction of the total energy in the inflaton field at the onset of inflation. This limit to Ωi is even smaller if a larger dark-flow tilt is allowed.

Parallel VI / **147**

Heavy graviton dark matter in bimetric theory

Author: Federico Urban[1]

[1] *KBFI*

Corresponding Author: federico.urban@kbfi.ee

Observational evidence for the existence of Dark Matter is limited to its gravitational effects. The extensive program for dedicated searches has yielded null results so far, challenging the most popular models. Here we propose that this is the case because the very existence of cold Dark Matter is a manifestation of gravity itself. Indeed, the only known ghost-free extension of General Relativity to additional spin-2 fields, bimetric theory, automatically contains a perfect Dark Matter candidate. The massive spin-2 particle can be heavy, stable on cosmological scales, and that it interacts with matter only gravitationally. Remarkably, these features persist in the same region of parameter space where bimetric theory satisfies current gravity tests. The observed Dark Matter abundance can be generated via freeze-in. Heavy graviton Dark Matter can be singled out in indirect detection experiments via its universal decay into all standard matter channels.

Summary:

Observational evidence for the existence of Dark Matter is limited to its gravitational effects. The extensive program for dedicated searches has yielded null results so far, challenging the most popular models. Here we propose that this is the case because the very existence of cold Dark Matter is a manifestation of gravity itself. Indeed, the only known ghost-free extension of General Relativity to additional spin-2 fields, bimetric theory, automatically contains a perfect Dark Matter candidate. The massive spin-2 particle can be heavy, stable on cosmological scales, and that it interacts with matter only gravitationally. Remarkably, these features persist in the same region of parameter space where bimetric theory satisfies current gravity tests. The observed Dark Matter abundance can be generated via freeze-in. Heavy graviton Dark Matter can be singled out in indirect detection experiments via its universal decay into all standard matter channels.

Parallel VI / **226**

Explaining the Standard Model criticality from Coleman's Theory

Author: Kiyoharu Kawana[1]

[1] *Kyoto University*

Corresponding Author: kiyokawa@gauge.scphys.kyoto-u.ac.jp

The observed Higgs mass indicates that its quartic coupling and beta function (and also bare mass) can simultaneously vanish around the Planck scale. Such a non-trivial behavior of the Higgs potential is called the criticality of the Standard Model. Here, we show that it can be explained based on the Coleman's multi-local theory.

Summary:

Plenary Sesion 8 / **183**

Astrophysics and particle physics with IceCube and beyond

Corresponding Author: deyoung@pa.msu.edu

The IceCube Neutrino Observatory, the world's largest neutrino detector, has been fully operational at the Amundsen-Scott South Pole Station since 2011. IceCube has discovered a flux of high energy neutrinos of extraterrestrial origin, and the latest results on the characterization of this flux and investigations into its origin(s) will be presented. In addition, IceCube is sensitive to a wide range of topics in particle physics. Current results from searches for dark matter, measurements of neutrino oscillations, and searches for sterile neutrinos will be shown, and future plans for the IceCube-Gen2 observatory and PINGU neutrino physics array will be discussed.

Summary:

Plenary Sesion 8 / **181**

Progress And Prospects of Reactor Neutrino Experiments

Corresponding Author: k_luk@berkeley.edu

Summary:

Plenary Sesion 8 / **182**

Long baseline neutrinos

Corresponding Author: j.j.hartnell@sussex.ac.uk

Summary:

Plenary Sesion 8 / **221**

Magnetic Moments against Majorana, Right-handed W against leptogenesis

Corresponding Author: frere@ulb.ac.be

Magnetic moments are forbidden for 2–component neutrinos (Weyl/Majorana), but transition moments are allowed ...and undistinguishable! Yet, triangular inequalities could help spot the difference! Leptogenesis is the most sturdy form of baryon number violation, but seems impossible to verify ...Discovering a right-handed W at a collider near you might falsify it!

Summary:

Plenary Session 10 / **188**

Higher Spins and Strings

Theories of massless higher spin gauge fields were seen as curiosities until recently. In the last decade or so these theories have played a larger role in string theory. I will give a broad overview of this subject and how the Vasiliev higher spin theory in AdS captures large N field theories in 2d and 3d. These are tractable yet nontrivial, often non-supersymmetric examples of the AdS/CFT correspondence. I shall also indicate why these theories will play a role in understanding the underlying symmetries of string theory.

Summary:

Plenary Session 10 / **187**

Quantum Field Theories in Higher Dimensions

Corresponding Author: kimyeong@gmail.com

Summary:

Plenary Session 11 / **190**

DM detection: phenomenology

Corresponding Author: paolo.gondolo@utah.edu

Summary:

Plenary Session 11 / **189**

Dark Matter Interactions and Impact on Structure Formation

Corresponding Authors: celine.boehm@cern.ch, celine.boehm1@gmail.com

Summary:

Plenary Session 11 / **191**

Dark matter and new phenomena searches at CMS

Corresponding Author: bjoern.penning@cern.ch

Summary:

Plenary Session 12 / **193**

Lepton flavor violation in BSM Higgs

Corresponding Author: antonio.delgado@nd.edu

Summary:

Plenary Session 12 / **194**

BSM Higgs searches at the LHC

Corresponding Author: goussiou@u.washington.edu

Summary:

Plenary Session 12 / **192**

New physics and dark matter searches from ATLAS

Corresponding Author: farid.ould-saada@fys.uio.no

Summary:

Plenary Session 12 / **222**

Indirect searches of New Physics with very rare decay at LHCb

Corresponding Author: thibaud.humair@cern.ch

Plenary Session 13 / **196**

Belle-II

Corresponding Author: akimasa.ishikawa@cern.ch

Summary:

Plenary Session 13 / **195**

SuperCDMS

Corresponding Author: serfass@berkeley.edu

Plenary Session 13 / **197**

ILC

Corresponding Author: tomohiko.tanabe@cern.ch

Summary:

Plenary Session 13 / **198**

CEPC-SppC Accelerator Status

Corresponding Author: gaoj@ihep.ac.cn

In this talk we will give a bird view of the status Circular Electron Positron Collider (CEPC). The scientific goal and the collider design goal of CECP are described. The luminosity potentail of Super Proton-Proton Collider (SPPC) in the same tunnel of CEPC are also provided. The optimization of parameter designs for CEPC with different energies, machine lengthes, single ring and crab-waist collision partial double ring options, etc. have been given systimatically. The machine lattice design philosophy and conrete lattice design are given. The corresponding SC RF system designs corresponding to different machine options are presented. Key issues for technology R&D and possible time schedule are addressed.

Summary:

Plenary Session 14 / **153**

LIGO experiment

Corresponding Author: yuri.levin@monash.edu

Summary:

Plenary Session 2 / **155**

Standard Model Higgs boson studies at the LHC

Corresponding Author: aurelio.juste.rozas@cern.ch

Summary:

Plenary Session 2 / **154**

High energy neutrinos

Summary:

Plenary Session 2 / **168**

Top quark studies

Corresponding Authors: ajung@fnal.gov, andreas.werner.jung@cern.ch

Summary:

Plenary Session 3 / **167**

Standard model and EW measurements at ATLAS and CMS

Corresponding Author: alberto.belloni@cern.ch

Summary:

Plenary Session 3 / **170**

A Guide to survive in early results of LHC RUN II: Long term prospects

Corresponding Author: nojiri@post.kek.jp

Summary:

Plenary Session 3 / **169**

Challenging the CKM picture of CP violation in the Standard Model at LHCb

Corresponding Author: giovanni.punzi@cern.ch

Plenary Session 4 / **171**

Natural SUSY phenomenology at LHC

Corresponding Author: tata@phys.hawaii.edu

Summary:

Plenary Session 5 / **175**

Current status of Dark Energy and beyond

Corresponding Author: shinji@rs.kagu.tus.ac.jp

We present recent observational bounds on dark energy constrained by the type Ia supernovae, cosmic microwave background, and baryon acoustic oscillations. We review a number of theoretical approaches that have been adopted so far to explain the origin of dark energy. This includes the cosmological constant, modified matter models (such as quintessence, k-essence), and modified gravity models (such as f(R) gravity, Galileons, Horndeski theories, massive gravity or vector theories). We distinguish between such theoretical models by taking into account recent observational data of red-shift space distortions and solar-system constraints.

Summary:

Plenary Session 5 / **132**

Overview of Planck results

Author: Collaboration PLANCK[1]

Co-author: Eric Hivon

[1] *ESA*

Corresponding Author: hivon.eric@gmail.com

The European Space Agency's Planck satellite, dedicated to studying the early Universe and its subsequent evolution, was launched in May 2009 and scanned the microwave and submillimetre sky continuously up to late 2013. This talk gives an overview of the main characteristics of the data and the data products now released, in temperature and polarization, as well as the associated cosmological and astrophysical science results.
The science products include maps of the cosmic microwave background (CMB), the thermal Sunyaev-Zeldovich effect, and diffuse foregrounds in temperature and polarization, catalogues of compact Galactic and extragalactic sources, and extensive simulations of signals and noise used in assessing the performance of the analysis methods and estimation of uncertainties.
Scientific results include cosmological parameters deriving from CMB power spectra, gravitational lensing, reionization history and cluster counts, as well as constraints on inflation, non-Gaussianity, primordial magnetic fields, dark energy, and modified gravity.

Summary:

Plenary Session 5 / **172**

Inflation and gravitational waves

Corresponding Author: valerie.domcke@sissa.it

Gravitational waves are unique messengers to explore the very early universe, probing energy ranges far beyond the reach of photon or even neutrino astronomy. The holy grail in this context is the stochastic gravitational wave background of cosmic inflation, which would shed light on the microphysics of inflation as well as on the entire subsequent cosmological history. In the simplest model of inflation this signal is however beyond the reach of current and planned gravitational wave interferometers. After reviewing this standard picture, I will discuss how modifications of this standard scenario can be a real game-changer, boosting the primordial gravitational wave signal into the range accessible by experiments such as eLISA and LIGO/VIRGO.

Summary:

Plenary Session 6 / **176**

DES Experiment

Corresponding Author: marcelle@fnal.gov

Summary:

Plenary Session 6 / **177**

Models of inflation

Corresponding Author: gary.m.shiu@gmail.com

Summary:

Plenary Session 7 / **178**

Neutrino Mixing, Leptonic CP Violation and Neutrino Masses from Discrete Flavor Symmetries

Corresponding Author: petcov@he.sissa.it

Summary:

Plenary Session 7 / **97**

Neutrinoless double-beta decay: First results of GERDA Phase II and the status of other experiments

Author: Alexey Lubashevskiy[1]

[1] *MPIK*

Corresponding Author: alexey.lubashevskiy@mpi-hd.mpg.de

GERDA is a low background experiment aimed for the serach of neutrinoless double beta ($0\nu\beta\beta$) decay. The observation of such a process would demostrate the presence of a Majorana term in the neutrino mass and prove that lepton number is not conserved. The experimental setup is located at the LNGS underground laboratory of INFN in Italy. The search is performed with high purity germanium detectors operated in liquid argon (LAr). The detectors are enriched in ^{76}Ge to 86%. GERDA Phase I was successfully completed with the best background level in the field (if normalized to region of interest) of 10^{-2} counts/(keV•kg•yr). Accumulated statistics allows to derive the most stringent lower limit on the half-life for the $0\nu\beta\beta$ of ^{76}Ge: T $^{0\nu}_{1/2}$ > 2.1•10 ^{25} yr at 90 % C.L. Phase II of the experiment with 30 newly produced Broad Energy Germanium (BEGe) detectors plans to reach an exposure of about 100 kg•yr. BEGe detectors have better resolution and powerful pulse shape discrimination capability which helps to suppress background events. Phase II is equipped with a LAr scintillation veto for further reduction of the background level. The goal of Phase II is to reach a sensitivity for the $0\nu\beta\beta$ decay half-life of T $^{0\nu}_{1/2}$ > 10 ^{26} at 90 % C.L. The installation of Phase II was completed and all detectors were deployed in December 2015. The status of GERDA Phase II experiment will be presented.

Summary:

Plenary Session 7 / **179**

Fertile neutrinos

Corresponding Author: fefo@ucol.mx

Abstract: Electroweak scale right-handed neutrinos have become a commodity in recent years. Most scenarios involve the so-called sterile neutrino paradigm, where right-handed neutrinos are assumed to be completely neutral under the Standard Model gauge group. A more interesting possibility is - of course - one in which they do interact. Such a fertile (non-sterile) possibility is certainly important phenomenologically and in this talk I will briefly review what has been explored so far for fertile right-handed neutrinos. I will show that they are not only phenomenologically viable but that their general setup provides very appealing theoretical and model building possibilities that I believe have been overlooked.

Summary:

Plenary Session 9 / **184**

Charged Lepton Flavor Violation: An Overview

Corresponding Author: rhbob@fnal.gov

Summary:

Plenary Session 9 / **186**

CLFV theory review

Corresponding Author: joe@phy.saitama-u.ac.jp

Plenary Session 9 / **185**

Final results of the MEG experiment and status of MEG II

Corresponding Author: giovanni.signorelli@cern.ch

The MEG experiment at PSI searched for the lepton-flavour violating decay mu -> e gamma with unprecedented sensitivity. The experiment ran for 5 years from 2009 to 2013 and it already set the most stringent experimental bound to date to be <5.7 x 10^-13 with an associated sensitivity of about 7.7 x 10^-13 from half of the statistics. I will present the MEG final result which has an associated sensitivity of 5.3 x 10^-13 based on the analysis of the whole data sample.

An experiment upgrade is conceived in order to further improve the sensitivity by at least one order of magnitude in three years of data taking. It will take benefit of the MEG infrastructures as the beam lines, the magnet and the calorimeter cryostat and technology, while the detectors and the TDAQ electronics were re-designed to cope with a doubled muon stopping rate. The MEG II experiment is currently under construction, the commissioning is foreseen between the end of this year and the first months of 2017. I will overview the new detector and describe the most important improvements.

Summary:

Summaries and closing / 203

Closing remarks

Summaries and closing / 180

Summary and perspectives III: Neutrino and precision measurements

Corresponding Author: lindner@mpi-hd.mpg.de

Summary:

Summaries and closing / 201

Summary and perspectives II: Collider Directions

Corresponding Author: rohini.godbole@cern.ch

Summaries and closing / 200

Summary and perspectives I: DM/DE/Cosmology

Corresponding Author: jihnekim@gmail.com

Summary:

Welcome and Opening Plenary / 150

Welcome

Corresponding Authors: pqh@virginia.edu, jtrantv@gmail.com

Welcome and Opening Plenary / 151

Perspectives on String Theory by David Gross

Corresponding Author: gross@kitp.ucsb.edu

Summary:

Welcome and Opening Plenary / **152**

Neutrino oscillation experiments

Corresponding Author: kajita.takaaki@gmail.com

Summary:

95

String cosmological models in $f(R,T)$ gravity

Author: Pradyumn Kumar Sahoo[1]

[1] *Birla Institute of Technology and Science-Pilani, Hyderabad Campus*

Corresponding Author: sahoomaku@rediffmail.com

Non-singular Bianchi-III and VI_0 string cosmological models filled with perfect fluid in the framework of $f(R,T)$ gravity are presented. The model initially accelerates for a certain period of time and decelerates thereafter. The physical behaviour
of the model is also studied.

Summary:

We have studied Bianchi type-III and VI_0 metrics in $f(R,T)$ gravity proposed by Harko et al. (2011). We have considered the source of matter as perfect fluid with one dimensional strings. Exact solutions of the $f(R,T)$ gravity field equations are obtained by choosing a special value for the average scale factor of the model which corresponds to a time-dependent deceleration parameter. The string tension density vanishes for Bianchi-III whereas for Bianchi-VI_0 it exist. In both the cases the energy density is positive and decreasing function of time. The physical parameters θ, H, σ^2 are decreasing function of time and tend to zero as $t \to -\infty$ for both the models. Since $\frac{\sigma^2}{\theta^2} \neq 0$, both the models are anisotropic throughout the evolution of the universe.