Curriculum Vitae

Shao-Feng Ge

Contact Information

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Research Interests

1) Model building:	Neutrino Theory Electroweak Theory
2) Phenomenology:	Neutrino Experiments Collider Physics Dark Matter Parton Shower & Jet
3) Simulation & Software Development	

1. Employment

- October 2017 – : Project Researcher, Joint appointment by the University of California at Berkeley (USA) and Kavli IPMU (WPI) at the University of Tokyo (Japan)
- October 2014 – October 2017: Guest Scientist at Max-Planck-Institut für Kernphysik (Germany)
- September 2012 – September 2014: JSPS Fellow at KEK Theory Center (Japan)

2. Education

- August 2006 – January 2012: Ph.D in Particle Physics
  Center for High Energy Physics, Tsinghua University (TUHEP), Beijing, China

  Thesis: "*Symmetry Breaking and Mass Generation Mechanism: Left-Right Symmetric Model and Neutrino Mixing*"
  Advisor: Hong-Jian He
- January 2009 – January 2010: Joint Education (China Scholarship Council)
  Center for Particles and Fields, Physics Department, University of Texas at Austin, USA
  Advisor: Duane A. Dicus
- September 2002 – July 2006: Bachelor of Philosophy in Physics
  Department of Physics, Tsinghua University, Beijing, China
  (Awarded Yeh Chi-Sun Prize, the HIGHEST undergraduate prize)

  Thesis: "*Neutrino Mass, Mixing and Flavor Symmetries*"
  (Excellent Bachelor Thesis of Tsinghua University)
  Advisor: Hong-Jian He

3. Awards, Prize, and Grants

- 2018: Grant-in-Aid for Young Scientists from JSPS (2,400,000 JPY) [Project Investigator]
- 2017: Fermilab Neutrino Physics Center Scholar Program
- 2014: Grant-in-Aid for Scientific Research from JSPS (600,000 JPY)
- 2013: Grant-in-Aid for Scientific Research from JSPS (1,000,000 JPY)
- 2012: Grant-in-Aid for Scientific Research from JSPS (800,000 JPY)
- 2012: JSPS Fellowship
- 2011: Tsinghua University Second Class Scholarship
- 2008: Joint Education Scholarship by the China Scholarship Council (CSC)
- 2007: Tsinghua University Second Class Scholarship
- 2006: Tsinghua University Yeh Chi-Sun Prize, Rank First
  (the HIGHEST prize for bachelors of Physics Department)
- 2006: Beijing Excellent Undergraduate Prize
- 2006: Tsinghua University Excellent Bachelor Thesis Prize
- 2006: Certificate of Achievement for Interdisciplinary Contest in Modeling
- 2005: Second Prize for National Undergraduate Math Modeling
- 2005: Tsinghua University First Class Scholarship
- 2004: National First Class Scholarship
- 2003: National Second Class Scholarship

4. Publication in refereed journals, citations: 815 [InSpire]

Below are my papers submitted to arXiv and published at various journals until July 24, 2018 with information of impact factor (IF) and citation numbers recorded by inSpire. Each item has been supplemented with a comment to summarize briefly the major contribution to the studied subject and its influence in the community. Newer publications can be found on inSpire, "http://inspirehep.net/search?ln=en&p=author%3AShao.Feng.Ge.1+AND+collection%3Aciteable".

1. "**Large Leptonic Dirac CP Phase from Broken Democracy with Random Perturbations**"
   Shao-Feng Ge, Alexander Kusenko, Tsutomu T. Yanagida
   Accepted to appear in Phys. Lett. B [arXiv:1803.03888 [hep-ph]] (inSpire), citations: 2

Residual symmetry (Paper 21, Paper 22, and Paper 23) and anarchy model are two independent approaches in the model building of neutrino mixing pattern. We propose a new approach of combining residual symmetry and random perturbations. By definition, residual symmetry is the one that can survive symmetry breaking. If residual symmetry is also broken, which is quite usual, there would be no other fundamental principle but random deviations to regulate the mixing pattern. Since the basic features of mixing pattern is determined by residual symmetry, the deviations cannot be too large and hence the random deviations have to be perturbative. Comparing with anarchy model, our approach can benefit from residual symmetries to give much better predictions.

To demonstrate the idea we propose a phenomenological model with residual $\mathbb{S}_3$ symmetries to dictate democratic mass matrices in quark and charged lepton sectors. It is sarcastic to see that democratic mass matrix can lead to extreme hierarchy with only one nonzero mass eigenvalue. In order to eliminate vanishing mass eigenvalues and account for realistic mixing pattern, the democratic mass matrices can only be approximately true and need to be perturbed, hence broken democracy. Although the perturbations are random, the prediction naturally prefers a large leptonic Dirac CP phase which is consistent with current global fit.

Some metaphors for entertainment:

$$\text{Double } \mathbb{S}_3 \Rightarrow \text{Democratic Matrix} \Rightarrow \text{Extreme Hierarchy} \Rightarrow \text{Unavoidable Chaos}$$

The double $\mathbb{S}_3$ is the check and balance among (Administration, Legislation, and Jurisdiction) or (People, States, and Federal) as the fundamental system design behind the democracy in US. The double $\mathbb{S}_3$ is necessary to dictate the democratic mass matrix, not any single one. However, the formally democratic mass matrix leads to extreme hierarchy in mass eigenvalues, $m_1 = m_2 = 0$ while $m_3 = \mathcal{O}(1)$. Richer people have more influence and can take advantage of the formal democracy, further enlarging the difference in income and social status. This unavoidably leads to chaos as random deviations to restore nonzero values for m_1 and m_2, fortunately or unfortunately in a perturbative way. Even for mixing, the up and down quarks can have large mixing among themselves but not significant mixing between the two sectors. What a natural mechanism to suppress mixing between the up and down classes, even in presence of democratic $\mathbb{S}_3$.

2. "**Constraining Gluonic Quartic Gauge Coupling Operators with** $gg \to \gamma\gamma$"

   John Ellis, Shao-Feng Ge

   Phys. Rev. Lett. 121, 041801 [arXiv:1802.02416 [hep-ph]] (inSpire)

   We explore the gluonic quartic gauge coupling (gQGC) operators, which is a natural Born-Infeld extension of the Standard Model as established by string theory, for the first time. The 13TeV ATLAS data on the diphoton production can already set a stringent bound on the scale of gQGC operators via the $gg \to \gamma\gamma$ scattering, $M \gtrsim 1.5\,\text{TeV}$. We further discuss the optimized strategy and sensitivity prospect at future hadron colliders such as HL-LHC, HE-LHC, FCC-hh and SppC where the lower limit on the gQGC scale can penetrate the multi-TeV range. This paper opens up a totally new direction of gluonic QGC in addition to the extensively discussed electroweak QGC.

3. "**Flavor Structure of the Cosmic-Ray Electron/Positron Excesses at DAMPE**"
   Shao-Feng Ge, Hong-Jian He, Yu-Chen Wang
   Phys. Lett. B781 (2018) 88-94 [arXiv:1712.02744 [astro-ph.HE]] (inSpire), citations: 14
   We observe that the DAMPE result has not only a sharp peak at 1.4 TeV but also a wide non-peak-like excess in the (0.6-1.1)TeV region. This hidden excess can also be explained by the annihilation of 1.4 TeV dark matter particles, but with final states being muons or taus which further decay to electrons and positrons. The appearance of both sharp electron/positron peak and wide muon/tau decay excess from the same 1.4 TeV dark matter annihilations is a strong support for the dark matter origin of the DAMPE excesses. To accommodate both excesses, the flavor composition should satisfy $N_e : N_\mu + \frac{1}{6} N_\tau \approx 1 : 12.7$. This points out a new direction for dark matter model buildings.

4. "**Constraining Photon Portal Dark Matter with TEXONO and COHERENT Data**"
   Shao-Feng Ge, Ian M. Shoemaker
   [arXiv:1710.10889 [hep-ph]] (inSpire), citations: 11
   The photon portal dark matter (DM) is one of the several limited ways of extending the Standard Model (SM) with renormalizable interactions. From kinetic mixing with the SM photon, or equivalently the $U(1)_Y$ gauge boson B, the dark sector $U(1)$ boson V' can replace photon in SM processes. This includes the Compton-like scattering $\gamma e^- \to V' e^-$ at the TEXONO experiment and the neutral pion decay $\pi^0 \to \gamma V'$ at the COHERENT experiment. The produced V' then decays into a pair of DM particles $V' \to \chi\chi$. Due to kinetic mixing, the DM particle χ can scatter with electron at TEXONO and nuclei via V' exchange at COHERENT. The DM-induced recoil events can fake the SM signal. Without seeing deviation from the SM predictions, the recent TEXONO and COHERENT data puts a stringent bound on the kinetic mixing and dark sector gauge coupling constant. Our result shows that at $\mathcal{O}$(MeV) scale, TEXONO and COHERENT puts stronger bounds than concurrent experiments.

5. "**Half-life Expectations for Neutrinoless Double Beta Decay in Standard and Non-Standard Scenarios**"
   Shao-Feng Ge, Werner Rodejohann, Kai Zuber
   Phys.Rev. D96 (2017) no.5, 055019 [arXiv:1707.07904 [hep-ph]] (inSpire), citations: 2
   We show the predicted probability distribution of half-life time of neutrinoless double beta decay with the current knowledge on neutrino oscillation, cosmology, and nuclear matrix elements. Three scenarios for the standard case, $3+1$ sterile neutrino case, and LRSM with Type-II seesaw case have been considered as bench mark.

6. "**Atmospheric Trident Production for Probing New Physics**"
   Shao-Feng Ge, Manfred Lindner, and Werner Rodejohann
   Phys.Lett. B772 (2017) 164-168 [arXiv:1702.02617 [hep-ph]] (inSpire), citations: 11
   We propose using the atmospheric neutrino trident production to probe new physics beyond the SM. A pair of muons in the final state is a distinctive signal at large water/ice Cherenkov detectors such as PINGU and ORCA with double muon tracks simultaneously

produced from the vertex. This can significantly enhance the physics potential of PINGU and ORCA by effectively turning neutrino telescope into particle collider. For illustration, we show their sensitivity on constraining an extra gauge boson Z' or scalar S' with coupling to the muon flavor. Essentially, we propose running neutrino experiment as neutrino collider. While neutrino experiment focuses on reconstructing the momentum and flavor of the initial-state neutrinos, neutrino collider can produce new particles and constrain their properties.

7. "**Extracting Majorana Properties in the Throat of Neutrinoless Double Beta Decay**"

   Shao-Feng Ge and Manfred Lindner,

   Phys.Rev. D95 (2017) No.3, 033003 [arXiv:1608.01618 [hep-ph]] (inSpire), citations: 9

   The latest cosmological data prefer NH and show sizable chance of non-observation of $0\nu2\beta$ decay at current experiments. We explore what information can be extracted in this situation. Non-zero $\langle m \rangle_{ee}$, hence observation of $0\nu2\beta$ decay, can fix only a combination of the two Majorana CP phases. In contrast, vanishing $\langle m \rangle_{ee}$ can determine the two Majorana CP phases simultaneously, which is actually a better scenario in the sense of constraining theoretical models. For the first time we,

   - define *Majorana Triangle* to show graphically how the two Majorana CP phases can be determined
   - explore the ability of JUNO/RENO-50 in reducing the uncertainty when extracting the Majorana CP phases
   - illustrate the required sensitivity of $0\nu2\beta$ experiments to extract non-trivial values of the two Majorana CP phases and touch the *Majorana Pyramid*.

8. "**Non-standard interactions and the CP phase measurements in neutrino oscillations at low energies**"

   Shao-Feng Ge and Alexei Yu. Smirnov,

   JHEP **1610** (2016) 138 [arXiv:1607.08513 [hep-ph]] (inSpire), citations: 21

   The CP sensitivity at current experiments, like T2K in Japan and NOνA/DUNE in USA, can be significantly reduced if there is non-standard interaction (NSI). Taking T2K as an example, the value of $\chi^2(\delta_D^{fit} = 90^\circ$ vs $\delta_D^{true} = -90^\circ)$ decreases by a factor of 3, from 9 to just 3. We show that TNT2K, T2K plus a μDAR (muon decay at rest) component as proposed in my earlier Paper 14, can help to stablize the CP sensitivity at T2K, increasing $\chi^2(\delta_D^{fit} = 90^\circ$ vs $\delta_D^{true} = -90^\circ)$ from 3 to 20, in the presence of NSI. The μDAR component of TNT2K can guarantee the sensitivity of CP measurement at T2K and generally other accelerator experiments. To show the effect of NSI parameters, we derive the oscillation probabilities analytically, giving a clear picture as the violation of vacuum mimicking.

9. "**Measuring the Leptonic CP Phase in Neutrino Oscillations with Non-Unitary Mixing**"

   Shao-Feng Ge, Pedro Pasquini, M. Tortola, and Jose W. F. Valle, Phys.Rev. D95 (2017) No.3, 033005 [arXiv:1605.01670 [hep-ph]] (inSpire), citations: 30

This paper proposes a way to guarantee the CP phase measurement at T2K against non-unitarity. The Dirac CP phase δ_D in neutrino mixing is a key parameter to explain why matter exists in the universe but does not annihilate completely with anti-matter and disappear altogether. Currently, the CP phase is under world-wide competition of experimental measurement. However, the CP sensitivity at accelerator-type experiments, like T2K and NOνA, will completely vanish under the theoretical assumption of non-unitary mixing rather than the conventional 3×3 unitary mixing. Even firm data can be obtained at T2K, which we believe, the interpretation of it can never be conclusive unless the two theoretical assumptions of unitary and non-unitary mixing can be distinguished experimentally. We propose a perfect solution by adding a near detector μNear to the TNT2K (T2K plus μKam) proposal in Paper 14.

10. "**Probing New Physics Scales from Higgs and Electroweak Observables at e^+e^- Higgs Factory**"

    Shao-Feng Ge, Hong-Jian He and Rui-Qing Xiao,

    JHEP **1610** (2016) 007 [arXiv:1603.03385 [hep-ph]] (inSpire), citations: 31

    This paper shows the ability of CEPC (Circular Electron Positron Collider) in China, on the precision measurement of Higgs couplings and indirectly probe of the new physics beyond the Standard Model (SM) of particle physics. Our study shows that it can probe new physics up to ~ 10 TeV with Higgs observables and 35 TeV (40 TeV for gluonic operators) if electroweak precision observables are used altogether. Due to this impressing ability, CEPC can pave road for the following SPPC (Super Proton Proton Collider). Our paper adds a new advantage and has became a key support for CEPC and SPPC, as well as FCC and ILC. When writing this paper, I started developing the BSMfitter package (Package 3).

11. "**Realizing Dark Matter and Higgs Inflation in Light of LHC Diphoton Excess**"

    Shao-Feng Ge, Hong-Jian He, Jing Ren and Zhong-Zhi Xianyu,

    Phys. Lett. B, **757** (2016) 480-492 [arXiv:1602.01801 [hep-ph]] (inSpire), IF: 6.131, citations: **54**

    Some evidence of a 750 GeV diphoton signal is observed at LHC (Large Hadron Collider) in December 2015. If verified, it would become the first observed new physics after the discovery of SM Higgs boson in 2012. Our paper explains the diphoton signal with a singlet scalar $\mathcal{S}$ and vector-like heavy quarks. In addition, our model can accommodate a dark matter candidate and stabilize the Higgs inflation potential up to the Planck scale for a successful inflation. Among the flood of paper on diphoton signal, our paper is one of the several that can explain several thing altogether in a single model.

12. "**New Physics Effects on Neutrinoless Double Beta Decay from Right-Handed Current**"

    Shao-Feng Ge, Manfred Lindner and Sudhanwa Patra,

    JHEP **1510** (2015) 077 [arXiv:1508.07286 [hep-ph]] (inSpire), IF: 6.111, citations: 31

    This paper studies the unique prediction of the Left-Right Symmetric Model (LRSM) with the Type-II seesaw mechanism and discusses how it can be tested by the next-generation of neutrinoless double beta decay ($0\nu2\beta$) experiments. More importantly, we propose a new method of using three different isotopes as detection materials to experimentally distinguish the new physics contribution of LRSM from the SM contribution. This points out a practical way of isolating new physics in $0\nu2\beta$ decay.

13. "**JUNO and Neutrinoless Double Beta Decay**"

    Shao-Feng Ge and Werner Rodejohann,

    Phys.Rev. D **92** (2015) No.9, 093006 [arXiv:1507.05514 [hep-ph]] (inSpire), IF: 4.643, citations: 10

    This study shows that the medium baseline reactor neutrino experiment JUNO in China can not only measure the neutrino mass hierarchy, see Paper 20, but also help the neutrinoless double beta decay ($0\nu2\beta$) experiment to reduce the uncertainty from neutrino oscillation parameters, especially the solar angle θ_s ($\equiv \theta_{12}$), to almost zero. Since our paper provides a strong support for JUNO, it is immediately cited by the following JUNO Yellow Book [arXiv:1507.05613].

14. "**The Leptonic CP Phase from T2(H)K and Muon Decay at Rest**"

    Jarah Evslin, Shao-Feng Ge and Kaoru Hagiwara,

    JHEP **1602** (2016) 137 [arXiv:1506.05023 [hep-ph]] (inSpire), IF: 6.111, citations: 15

    We propose a new type of neutrino experiment, Muon Decay at Rest (μDAR), to make better measurement on the leptonic Dirac CP phase δ_D. With T2(H)K running in neutrino mode while μDAR in anti-neutrino mode, the CP phase uncertainty as well as degeneracy between δ_D and $\pi - \delta_D$ can be significantly improved. This design of TNT2K (μKam added to T2K) is much better than the DAEδALUS proposed by US in four aspects:

    - μKam is cheaper with only one cyclotron source v.s. DAEδALUS needs three.
    - μKam cyclotron source can run with 100% duty factor v.s. each cyclotron source of DAEδALUS can only have 20% with 80% wasted.
    - μKam is technically much easier with 5 times lower luminosity than DAEδALUS. The μKam flux only needs to be larger than the world record holder PSI by a factor of 4 while DAEδALUS flux is larger by a factor of $16 \sim 20$.
    - Adding only one near detector to the single μKam source allows measurement on non-unitarity and guarantees the CP measurement, see Paper 9. On the other hand, DAEδALUS needs three near detectors added to its three sources to achieve the same thing.

    Supplemented with μKam, the T2K experiment can become much more competitive than other accelerator neutrino experiments.

15. "**The Georgi Algorithms of Jet Clustering**"

    Shao-Feng Ge,

    JHEP **1505** (2015) 066 [arXiv:1408.3823 [hep-ph]] (inSpire), IF:6.220, citations: 7

The jet clustering algorithm is an unavoidable method to reconstruct events at hadron colliders like the Large Hadron Collider (LHC) at CERN and future SPPC in China. The famous physicist Howard Georgi proposed in August 2014 a new algorithm with jet functions, which is totally different from the conventional ones. Nevertheless, he did not provide any theoretical explanation or verification. My paper establishes a sound proof that this new jet algorithm is consistent with the kinematics of parton shower process, hence explaining its viability, and provides further generalization of the original jet functions. This work appears online only two weeks after the original paper by Howard Georgi. Actually, it only takes me less than two days to read the Georgi paper, think about the possible explanation, try generalization, draft my own paper, and finally submit it to arXiv. Just days after its appearance on arXiv, I was invited to introduce this new algorithm for the 38-th General Meeting of ILC Physics Subgroup in the same month, see Talk 7.

16. "**Unifying Residual Symmetries and Quark-Lepton Complementarity**"
Shao-Feng Ge,
[arXiv:1406.1985 [hep-ph]] (inSpire), citations: 10
This paper generalizes the general framework of residual symmetries established in Paper 22 and Paper 21 for neutrino mixing to quark mixing. The residual $\mathbb{Z}_2$ symmetries indicated by the neutrino mixing can also predict the pattern in quark mixing, although it is totally different from neutrino mixing. This provides a unified picture of both neutrino and quark mixings. More interestingly, residual symmetry takes the same role as the famous custodial symmetry in electroweak symmetry breaking (EWSB):

- Full flavor symmetry cannot predict the mixing patter which is not only affected by CG coefficients (property of full flavor symmetry) but also Yukawa coupling and VEVs that is not under the control of flavor symmetry. $\Leftrightarrow$ Gauge symmetry cannot predict the weak mixing angle which is a function of gauge coupling constant that cannot be fixed by gauge symmetry.
- Full flavor symmetry has to break down to residual symmetry for fermions to acquire masses and mixing. $\Leftrightarrow$ Gauge symmetry has to break down to custodial symmetry for gauge bosons to acquire masses and mixing.
- Residual symmetry predicts correlation among physical observables (mixing angles and the leptonic Dirac CP phase δ_D). $\Leftrightarrow$ Custodial symmetry predicts correlation among physical observables (the weak mixing angle θ_w and the W/Z boson masses).

In other words, residual symmetry acts as effective field theory (EFT) in fermion mixing. This paper gives a much deeper understanding of residual symmetry and its phenomenological consequences.

17. "**Physics Reach of Atmospheric Neutrino Measurements at PINGU**"
Shao-Feng Ge and Kaoru Hagiwara,
JHEP **1409** (2014) 024 [arXiv:1312.0457 [hep-ph]] (inSpire), IF: 6.220, citations: 24
Based on Paper 18, we further explore the ability of PINGU on measuring the neutrino mass hierarchy and the octant of the atmospheric angle θ_a (θ_{23}) by taking into account

the detector response. Especially, we explore step by step the effects of intrinsic smearing from event reconstruction, energy and angular resolutions, muon misidentification rate, as well as data binning for inelasticity. Our result is consistent with the later result from full detector simulation of the whole PINGU Collaboration and the data binning for inelasticity is still their future goal for further improvement. Our result, together with Paper 18, is reported at CosPA13 (Conference 15) and has attracted much attention from the PINGU experimentalists. During the preparation of this paper, I started developing the simulation package NuPro (Package 2) for neutrino properties.

18. "**A Novel Approach to Study Atmospheric Neutrino Oscillation**"

    Shao-Feng Ge, Kaoru Hagiwara and Carsten Rott,

    JHEP, **1406**, 150 (2014) [arXiv:1309.3176 [hep-ph]] (inSpire), IF: 6.220, citations: 20

    We establish a decomposition formalism to disentangle the three currently unknown parameters: the leptonic Dirac CP phase δ_D, the octant of the atmospheric mixing angle θ_{23}, and the neutrino mass hierarchy. It is extremely convenient to show analytically the contribution of these three unknown parameters. Although this formalism is developed during our study of the atmospheric neutrino experiment PINGU for mass hierarchy and octant measurement, it can apply generally to any type of neutrino oscillation experiments, for example Paper 9 and Paper 17.

19. "**Phenomenological Consequences of Residual $\mathbb{Z}_2^s$ and $\overline{\mathbb{Z}}_2^s$ Symmetries**"

    Andrew D. Hanlon, Shao-Feng Ge and Wayne W. Repko,

    Phys. Lett. B, **729**, 185-191 (2014) [arXiv:1308.6522 [hep-ph]] (inSpire), IF: 6.019, citations: 34

    We study how the accelerator neutrino experiments T2K and NOνA can distinguish the residual $\mathbb{Z}_2^s$ and $\overline{\mathbb{Z}}_2^s$ symmetries that elaborated in Paper 21 and Paper 22. This paper is one of the first three papers, all appearing in a short period of ten days this August, that make thorough phenomenological study of lepton flavor symmetries with realistic simulation of neutrino experiments. Since neutrino physics has entered a precision era, after Daya Bay and RENO measured the reactor mixing angle θ_{13} in 2012, we expect the interplay between realistic phenomenological study of neutrino experiments and neutrino model building to become a new trend. In addition, we propose splitting the run time of accelerator neutrino experiments equally between neutrino and antineutrino modes to enhance and stabilize the octant sensitivity. The NuPro package (Package 2) that I'm developing is to facilitate the interplay of these two sub-fields of neutrino study.

20. "**Determination of mass hierarchy with medium baseline reactor neutrino experiments**"

    Shao-Feng Ge, Kaoru Hagiwara, Naotoshi Okamura and Yoshitaro Takaesu,

    JHEP, **1305**, 131 (2013) [arXiv:1210.8141 [hep-ph]] (inSpire), IF: 6.220, citations: **67**

    After Daya Bay neutrino experiment measured the reactor mixing angle θ_{13} in March 2012, the whole community moved on to design the next-generation of neutrino experiments. Our paper studies the hierarchy sensitivity and precision measurement of other oscillation parameters at medium baseline reactor neutrino experiments, now known as JUNO and RENO-50, especially the requirement on basic experimental configurations such as baseline length, run time, and energy resolution. In addition, we propose an analytic χ^2 fit procedure to estimate the statistical uncertainty on the interpretation of discrete variables such as the neutrino mass hierarchy. It is one of the several pioneer papers on this statistical issue and the only one using analytical method. This paper becomes an important part of the design contribution to the JUNO/RENO-50 experiment and is widely acknowledged across the community. The analytical χ^2 fit is further used in Paper 10 and two packages, BSMfitter (Package 3) and NuPro (Package 2).

21. "**Residual Symmetries for Neutrino Mixing with a Large θ_{13} and Nearly Maximal δ_D**"

    Shao-Feng Ge, Duane A. Dicus and Wayne W. Repko,

    Phys. Rev. Lett. **108**, 041801 (2012) [arXiv:1108.0964 [hep-ph]] (inSpire), IF: 7.943, citations: **164**

    We further explore the phenomenological consequences of the residual $\mathbb{Z}_2^s$ studied in Paper 22 and additionally the $\overline{\mathbb{Z}}_2^s$ symmetries. With indication of a nonzero reactor angle θ_{13} from T2K and MINOS, the only unknown parameter in neutrino mixing is the leptonic Dirac CP phase δ_D. We show that the correction from $\mathbb{Z}_2^s/\overline{\mathbb{Z}}_2^s$ can be used to express δ_D as a function of mixing angles. With the global fit as input for mixing angles, we predict an almost maximal value of δ_D, which is consistent with the global fit for the CP phase. Together with Paper 22, this framework of residual symmetry is claimed by the world-class neutrino expert Alexei Yu. Smirnov as one of the two directions to go beyond tribimaximal mixing in his review paper [arXiv:1305.4827] and has been widely acknowledged across the community.

22. "**$\mathbb{Z}_2$ Symmetry Prediction for the Leptonic Dirac CP Phase**"

    Shao-Feng Ge, Duane A. Dicus and Wayne W. Repko,

    Phys. Lett. B **702**, 220 (2011) [arXiv:1104.0602 [hep-ph]] (inSpire), IF: 6.019, citations: **124**

    The T2K data, released after the interruption of earthquake and Tsunami in March 2011, indicates a nonzero reactor mixing angle θ_{13}. Inspired by this, we further explore the phenomenological consequence of the residual $\mathbb{Z}_2^s$ symmetry studied in Paper 23 and generalize it to include the leptonic Dirac CP phase δ_D. The resulting correlation between the three mixing angles and δ_D predicts a nonzero θ_{13} which is consistent with T2K data and the conclusive measurement at Daya Bay (also RENO) in 2012. Together with Paper 21 we establish a general framework to make phenomenological study of residual symmetries.

23. "**Generalized Hidden $\mathbb{Z}_2$ Symmetry of Neutrino Mixing**"

    Duane A. Dicus, Shao-Feng Ge and Wayne W. Repko,

    Phys. Rev. D **83**, 093007 (2011) [arXiv:1012.2571 [hep-ph]] (inSpire), IF: 4.97, citations: 19

    Inspired by the C.S. Lam papers on horizontal symmetry (thanks to Prof. Hong-Jian He for introducing these papers), we noticed that the full horizontal symmetry has to be broken in order to generate non-trivial neutrino mixing. If there is any symmetry that dictates the neutrino mixing pattern, it has to be a residual symmetry that survives symmetry breaking, rather than the full horizontal symmetry. We also establish direct connection between residual symmetry and mixing angles. This idea of residual symmetry and its close connection with mixing will be further developed in Paper 21 and Paper 22.

24. "**Neutrino Mixing with Broken S_3 Symmetry**"

    Duane A. Dicus, Shao-Feng Ge and Wayne W. Repko,

    Phys. Rev. D **82**, 033005 (2010) [arXiv:1004.3266 [hep-ph]] (inSpire), IF: 4.89, citations: 28

    This paper uses the representation matrices of the broken S_3 symmetry to construct the neutrino mass matrix and predict the mixing pattern.

25. "**Common Origin of Soft μ–τ and CP Breaking in Neutrino Seesaw and the Origin of Matter**"

    Shao-Feng Ge, Hong-Jian He and Fu-Rong Yin,

    JCAP **1005**, 017 (2010) [arXiv:1001.0940 [hep-ph]] (inSpire), IF: 7.72, citations: **72**

    We notice that CP effect can appear in neutrino mixing only when μ–τ is broken. Based on this observation, we propose common origin of μ–τ and CP breaking. For illustration, we provide a realization in minimal seesaw. The deviations from μ–τ and CP symmetries are correlated with each other, which leads me to find the correlation predicted by residual symmetries in Paper 21 and Paper 22. In addition, the low-energy CP phase δ_D can explain the origin of matter in our Universe via leptogenesis. T.D. Lee and R. Friedberg noticed our paper and made detailed comparison with their own model in [arXiv:1008.0453].

5. Proceedings

1. "**Measuring the Leptonic Dirac CP Phase with TNT2K**"

   Shao-Feng Ge

   NuPhys2016: Prospects in Neutrino Physics, Barbican Centre, London, UK, December 12-14, 2016, [arXiv:1704.08518 [hep-ph]] (inSpire), citations: 1

2. "**Testing Higgs Coupling Precision and New Physics Scales at Lepton Colliders**"

   Shao-Feng Ge, Hong-Jian He, and Rui-Qing Xiao

   IAS Program on High Energy Physics, Hong-Kong Universtiy of Science and Technology, Hong-Kong, China, January 11, 2016, Int. J. Mod. Phys. A **31**, 1644004 (2016), [arXiv:1612.02718] (inSpire), citations: 3

   I reported the results of our Paper 10 at the workshop.

6. Other publication

1. "**Phenomenological Support for Residual $\mathbb{Z}_2$ Symmetries in Neutrino Mixing**," Shao-Feng Ge, Duane A. Dicus and Wayne W. Repko,
   "Research Hightlights" in Asia Pacific Physics Newsletter, August 2012, Volume 1, No. 2, World Scientific Publishing.
   I was invited to introduce our PRL Paper 21 for the opening issue of Asia Pacific Physics Newsletter. Finally it appears on the second issue.

7. Medium Coverage

1. Fermilab Q&A with Shao-Feng Ge: Planning the next wave of neutrino experiments, August 24, 2018

8. Service as Peer-Review Referee

1. Chinese Physics C
2. International Journal of Modern Physics A
3. Journal of High Energy Physics
4. Nuclear Physics B
5. Physical Review D
6. Physical Review D Rapid Communications
7. Physics Letters B

9. Participation in Experimental Design

1. "**CEPC-SPPC Preliminary Conceptual Design Report** (preCDR)," [link].
   I started participating this project since the Spring Festival of 2014 and contributed the following,
   - Extracting the Higgs coupling precision from the precision of CEPC on cross sections and branching ratios from Detector Simulation Group. The result has been summarized as Figure 3.19 (top panel) and Figure 3.20 (top panel) CEPC preCDR. This is the key analysis for the major goal of precision Higgs measurement at CEPC and is carried out by the technique of analytical χ^2 fit that I have been developing.

- Our Paper 10 explores the scale of new physics beyond Standard Model that CEPC can directly explore and how this measurement at low-energy CEPC can support the high-energy extension SPPC. In addition, we point out that the precision observables at CEPC can be as important as the Higgs observables. This enhances the physics potential of CEPC and points out a new direction to pursue more results.
- I have been developing the BSMfitter package (Package 3) for the physical analysis of CEPC data to facilitate the communication between theorists and experimentalists. It has already been used to extract the Higgs coupling precision and the new physics scale from indirect probe at CEPC, see the above two points. Once ready, I will release this package for the whole community to use. It can be very useful for the research at CEPC.
- Talks at various occasions, see Talk 4, Talk 5, Talk 12, Talk 13, and Talk 23.

2. "**Letter of Intent: Jinping Neutrino Experiment**,"

   [arXiv:1602.01733 [physics.ins-det]].

   I contributed to explore the possibility of measuring the neutrino mass hierarchy with atmospheric neutrinos at Jinping site. I help to the organization of the *2015 Workshop of Jinping Neutrino* (Conference 24) and report on atmospheric/accelerator neutrino experiments (Talk 6). [I was listed as author up to the second version, but removed from the third version just because of MPIK's group policy on experimental collaborations.]

3. "**TNT2K – Tokai and Toyama to Kamioka**,"

   We propose adding a μDAR component to the existing T2K and future T2HK experiments for better measurement of the leptonic Dirac CP phase. Its advantages have been studied in Paper 14, Paper 9, and Paper 8.

   Comparing with the original T2(H)K design, it has five advantages,

   - Much larger event numbers
   - Much better CP sensitivity around maximal CP
   - Solve degeneracy between δ_D and $\pi - \delta_D$
   - Guarantee CP sensitivity against non-unitary mixing
   - Guarantee CP sensitivity against non-standard interactions

   Comparing with DAEδLUS, which also uses μDAR, our design is better with,

   - Only one cyclotron
   - 100% duty factor
   - Much lower flux intensity
   - Technically easier
   - Much cheaper
   - Single near detector

10. Software Development

1. "**Mad-ee: The leptonic collider extension to MadGraph**,"

   I have been working with the MadGraph group to develop a Mad-ee add-on to simulate beamstrahlung and initial-state radiation (ISR). Once finished, it can benefit the whole community of future lepton colliders, such as CEPC, FCC-ee, and ILC.

2. "**NuPro: A Simulation Package for Neutrino Properties**," [HepForge]

   NuPro is designed to go beyond the well-know GLoBES, which can only simulate fixed-baseline neutrino experiments, to simulate all possible experiments of neutrino properties,

   - Fixed-baseline experiments:
     - Reactor
     - Accelerator
   - Multi-baseline experiments:
     - Atmospheric
     - Solar
     - Very short baseline experiments
   - Decay experiments:
     - Beta decay
     - Two neutrino double beta decay
     - Neutrinoless double beta decay
     - Geo-neutrino
   - Cosmological measurements:
     - Mass sum from CMB, LSS, ...
     - Direct measurement of cosmic neutrino background

   Written in C++, NuPro has much more convenient user interface than GLoBES. Currently, it has been used to produce Paper 7, Paper 8, Paper 9, Paper 12, Paper 13, Paper 14, and the study on atmospheric neutrino measurement for Jinping neutrino experiment (Experiment 2). Once finished, I will release it for public use to boost the neutrino research in China and the whole world.

3. "**BSMfitter: Beyond Standard Model Fitter**," [HepForge]

   BSMfitter is developed during my participation of CEPC preCDR (Experiment 1) and Paper 10 on the new physics scales to be probed indirectly at future lepton colliders. The basic features are,

   - **Experimental Data**

     All observables such as precision measurement of Higgs couplings and electroweak precision observables. I plan to include all the data from both existing experiment, such as LHC and ILC, and simulation for future experiments, especially CEPC and

SPPC in China. Experimentalists can provide data and simulation for theorists to constrain their models.

- **Theoretical Models**
  To provide a convenient user interface, the code can understand analytical expressions. So theorists just need to describe their model in a text file. The code can read in data and model files to check automatically to what extend the model is consistent with data and how the model parameters are constrained. All the nasty work of statistical fitting will be taken care of by the code automatically.

Once done, it can significantly facilitate the interaction between experimentalists and theorists of model building.

11. Invited Talks

1. "*Atmospheric Neutrino Trident Production and Neutrino Collider*",
   Advanced Workshop on Physics of Atmospheric Neutrinos (PANE 2018), ICTP, Trieste, Italy, May 28 - June 1, 2018
2. "*Atmospheric Neutrino Trident Production for Probing New Physics*",
   The 19th International Workshop on Neutrinos from Accelerators (NuFact2017), Uppsala University, Uppsala, Sweden, September 25-30, 2017
3. "*Light Dark Sector at Neutrino Experiments*",
   International Workshop on WIMP Dark Matter and Beyond, T.D.Lee Institute (TDLI) at SJTU, Shanghai, China, September 17-18, 2017
4. "*Higgs Coupling Precision and New Physics Scales @ CEPC*",
   CEPC-SPPC Workshop, Institute for High Energy Physics (IHEP), Beijing, April 8-9, 2016.
5. "*CEPC Higgs Physics*",
   Workshop on Physics at CEPC, Institute for High Energy Physics (IHEP), Beijing, August 10, 2015.
6. "*Atmospheric and Accelerator Neutrino Physics at Jinping Undergrand Laboratory*",
   Workshop of Jinping Neutrino Program, Tsinghua University, Beijing, June 5, 2015.
7. "*The Georgi Algorithms of Jet Clustering*",
   38th General Meeting of ILC Physics Subgroup, KEK, August 30, 2014.
8. "*The Dirac CP Phase δ_D @ T2(H)K and μDAR*",
   The 9th Workshop of TeV Physics Working Group in 2014 (TeV2014), Sun Yat-Sen (Zhongshan) University, Guangzhou China, May 15-18, 2014.

9. "*Phenomenology of Atmospheric Neutrino Oscillations with PINGU*",
The "Beyond θ_{13}" Workshop, University of Pittsburgh, Pittsburgh, USA, February 11-12, 2013.

10. "*Neutrino Hidden Symmetry beyond Tribimaximal*",
Workshop on Neutrino Physics in the Daya Bay Era (summoned by Nobel Laureat T.-D. Lee), China Center of Advanced Science and Technology, Beijing, China, November 4–5, 2010.

12. Talks in Conferences and Workshops

1. "*Measuring the Leptonic Dirac CP Phase with Muon Decay at Rest*,"
The 20th International Workshop on Neutrinos from Accelerators [NuFact 2018],
Virginia Tech, Blacksburg, Virginia, USA, August 13, 2018

2. "*Atmospheric Neutrino Trident Production and Neutrino Collider*,"
PACIFIC 2018, Akaigawa, Hokkaido, Japan, February 18, 2018

3. "*Future Opportunities in Neutrino Physics*,"
The IPMU-Berkeley Week, IPMU, Japan, January 10, 2017

4. "*Higgs Couplings & New Physics Scales @ Future Lepton Colliders*,"
"The 21th Regular Meeting of the New Higgs Working Group", Osaka University, Japan, December 23, 2017

5. "*Light DM @ Neutrino Experiments & Heavy DM @ DAMPE*,"
"International Symposium on Cosmology and Particle Astrophysics (CosPA 2017)", Kyoto, Japan, December 12, 2017

6. "*Neutrinoless Double Beta Decay in the Precision Era*," (remote talk by Skype)
INT Program INT-17-2a for Neutrinoless Double Beta Decay, Seattle, USA, July 14, 2017

7. "*Measuring the Leptonic Dirac CP Phase with Muon Decay at Rest*,"
CosPA 2016, Sydney, Australia, November 28, 2016

8. "*The New Physics Scales to be Probed at Lepton Colliders*," (remote talk)
IHEP-CERN Teleconference on Z Physics, November 16, 2016

9. "*Sensitivity of Muon Decay at Rest Experiments to CP Violation*," (remote talk by phone)
PhyStat-nu Fermilab 2016, USA, September 20, 2016

10. "*Testing Higgs Couplings and New Physics Scales at Lepton Colliders*,"
MITP EFT Workshop, Mainz, Germany, August 30, 2016

11. "*Reach of New Physics Scales via Higgs and Precision Observables at CEPC*,"
Kavli Institute for Theoretical Physics China at the Chinese Academy of Sciences (KITPC), Beijing, July 28, 2016

12. "*Higgs Precision Combination, New Physics Scales via Dimension-Six Operators, and Differential Distributions at CEPC*,"
CEPC Software Workshop, Institute for High Energy Physics (IHEP), Beijing, March 26, 2016

13. "*New Physics Scales to be Probed at Lepton Colliders (CEPC)*",
IAS Program on High Energy Physics, Hong-Kong University of Science and Technology, Hong-Kong, China, January 11, 2016

14. "*NuPro and GLoBES – Simulation Packages of Neutrino Physics*",
Software Workshop, Max-Planck-Institute für Kernphysik, Heidelberg, Germany, July 28, 2015

15. "*Physics of Atmospheric Neutrino Oscillations with a Huge Underground Detector*",
Symposium on Cosmology and Particle Astrophysics (CosPA) 2013, University of Hawaii (Manoa), Honolulu, Hawaii, USA, November 12-15, 2013.

16. "*Residual $\mathbb{Z}_2$ Symmetries Supported by Large θ_{13} and Nearly Maximal δ_D*",
KEK Theory Meeting on Particle Physics Phenomenology (KEK-PH2012), KEK, Tsukuba, Japan, February 27 – March 1, 2012.

17. "*Spontaneous Parity Violation, Electroweak Symmetry Breaking and LHC Signatures* ",
The Sixth TeV Physics Working Group Conference of China, University of Science and Technology of China, Hefei, China, May 21–22, 2011.

18. "*Puzzles of Neutrino Mixing and Anti-Matter: Hidden Symmetries and Symmetry Breaking* ",
The VII High Energy Physics Conference of China, Nanchang University, Nanchang, China, April 17–18, 2010.

19. "*Spontaneous Parity Violation and Induced Electroweak Symmetry Breaking* ",
The Second TeV Physics Working Group Conference of China, Liaoning Normal University, Dalian, China, August 27–30, 2007.

13. Poster Presentations

1. "*Probing New Physics with Atmospheric Neutrino Trident Production*," [slides, blog]
XVII International Workshop on Neutrino Telescopes, Palazzo Franchetti - Istituto Veneto di Scienze, Lettere ed Arti, Venice, Italy, March 13-17, 2017

2. "*CP Measurement with μDAR*,"
   NuPhys2016: Prospects in Neutrino Physics, Barbican Centre, London, UK, December 12-14, 2016
3. "*Neutrinoless Double Beta Decay*,"
   Internal Science Day, Max-Planck-Institut für Kernphysik, Heidelberg, Germany, September 24, 2015

14. Conference Participation

1. "The 20th International Workshop on Neutrinos from Accelerators" [NuFact 2018],
   Virginia Tech, Blacksburg, Virginia, USA, August 12-19, 2018
2. "PACIFIC 2018",
   Akaigawa, Hokkaido, Japan, February 13-19, 2018
3. "Kavli IPMU-Berkeley Week and Symposium (Statistics, Physics and Astronomy)",
   Kavli IPMU, Japan, January 10-12, 2017
4. "The 21th Regular Meeting of the New Higgs Working Group",
   Osaka University, Japan, December 22-23, 2017
5. "International Workshop Axion Physics and Dark Matter Cosmology",
   Osaka University, Japan, December 20-21, 2017
6. "KMI Workshop on Grand Unified Theories",
   Kobayashi-Maskawa Institute, Nagoya University, Japan, December 19, 2017
7. "MG5aMC Simulations for e^+e^- Colliders",
   Louvain, Belgium, December 12-13, 2017 (Vidyo Conference)
8. "International Symposium on Cosmology and Particle Astrophysics (CosPA 2017)",
   Yukawa Institute for Theoretical Physics, Kyoto University, Japan, December 11-15, 2017
9. "IPMU Focus Week on Primordial Black Holes",
   Kavli IPMU, the University of Tokyo, Japan, November 13-17, 2017
10. "Kavli IPMU 10th Anniversary Symposium",
    Kavli IPMU, the University of Tokyo, Kashiwa, Chiba, Japan, October 16-18, 2017
11. "International Workshop on WIMP Dark Matter and Beyond",
    T.D.Lee Institute (TDLI) at SJTU, Shanghai, China, September 17-18, 2017
12. "International Symposium on the Future of Physics and Astronomy
    Ceremony on the Inauguration of the Founding Director of Tsung-Dao Lee Institute",
    T.D.Lee Institute (TDLI) at SJTU, Shanghai, China, September 15-16, 2017

13. "2017 SJTU-KIT Collaborative Research Workshop: Particles and the Universe",
Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, September 6-8, 2017
14. "XVII International Workshop on Neutrino Telescopes,"
Palazzo Franchetti - Istituto Veneto di Scienze, Lettere ed Arti, Venice, Italy, March 13-17, 2017
15. "The Future of Neutrino Physics - A German Perspective on Topics, Opportunities and Challenges,"
MPIK, Heidelberg, Germany, February 23-24, 2017
16. "*NuPhys2016: Prospects in Neutrino Physics*,"
Barbican Centre, London, UK, December 12-14, 2016
17. "*The 13th International Symposium on Cosmology and Particle Astrophysics (CosPA 2016)*, "
Sydney Nanoscience Hub, Sydney, Australia, November 28 - December 2, 2016
18. "*Effective Field Theories as Discovery Tools*,"
Mainz Institute for Theoretical Physics (MITP), Mainz, Germany, August 22 - September 9, 2016
19. "CEPC-SPPC Workshop,"
Institute of High Energy Physics (IHEP), Beijing, China, April 8-9, 2016
20. "CEPC Software Workshop,"
Institute of High Energy Physics (IHEP), Beijing, China, March 26-27, 2016
21. "*IAS Program on High Energy Physics*,"
Institute for Advanced Study, Hong-Kong University of Science and Technology, Hong-Kong, China, January 6-30, 2016
22. "*Workshop on Physics at the CEPC*,"
Institute of High Energy Physics (IHEP), Beijing, China, August 10-12, 2015
23. "*25th International Workshop on Weak Interactions and Neutrinos* (WIN2015),"
Max-Planck Insitut für Kernphysik, Heidelberg, Germany, June 8-13, 2015
24. "*2015 Workshop of Jinping Neutrino*,"
Center for High Energy Physics, Tsinghua University, Beijing, China, June 5, 2015
25. "*International Conference on Massive Neutrinos*,"
Nanyang Technological University, Singapore, February 9-13, 2015
26. "*Neutrinos in Astro- and Particle Physics*,"
Munich Institute for Astro- and Particle Physics (MIAPP), Munich, Germany, June 30 - July 13, 2014

27. "*The 9th Workshop of TeV Physics Working Group in 2014 (TeV2014)*",
Sun Yat-Sen (Zhongshan) University, Guangzhou, China, May 15-18, 2014
28. "*4th Open Meeting for the Hyper-Kamiokande Project*,"
Kavli Institute for the Physics and Mathematics of the Universe (IPMU), Tokyo, Japan, January 27-28, 2014
29. "*Symposium on Cosmology and Particle Astrophysics (CosPA 2013)*,"
University of Hawaii, Honolulu, Hawaii, USA, November 12-15, 2013
30. "*MadGraph School 2013*,"
University of Chinese Academy of Sciences, Beijing, China, May 22-26, 2013
31. "*Beyond* θ_{13},"
University of Pittsburg, Pittsburg, USA, February 8-10, 2013
32. "*The Sixth TeV Physics Working Group Conference of China*,"
University of Science and Technology of China, Hefei, China, May 21–22, 2011
33. "*Workshop on Neutrino Physics in the Daya Bay Era*,"
China Center of Advanced Science and Technology, Beijing, China, November 4–5, 2010
34. "*International Conference & Summer School on LHC Physics*,"
Tsinghua University, Beijing, China, August 16-24, 2010
35. "*The VII High Energy Physics Conference of China*,"
Nanchang University, Nanchang, China, April 17–18, 2010
36. "*The Second TeV Physics Working Group Conference of China*,"
Liaoning Normal University, Dalian, China, August 27–30, 2007
37. "*Asian School of Particles, Strings and Cosmology (NasuLec)*,"
KEK (Larforlet Nasu Hotel), Japan, September 25-29, 2006
38. "*2006 Summer School on Beyond the Standard Model*,"
"*Topical Seminar on Frontier of Particle Physics 2006: Beyond the Standard Model*,"
Beijing, August 7-11, 2006
39. "*The First TeV Physics Working Group Conference of China*,"
Tsinghua University, Beijing, China, December 18, 2005
40. "*2005 International Symposium & Summer School on Linear Collider Physics, Detector and Accelerator*,"
Tsinghua University, Beijing, China, July 15-20, 2005

15. Talks at Colloquia, Seminars, and Journal Club

1. "*The Leptonic CP Phases: Dirac & Majorana*,"
   Seminar, Center for Neutrino Physics at Virginia Tech, Blacksburg, Virginia, USA, August 21, 2018
2. "*Dark Matter, Neutrino & Collider – Searches of New Physics beyond the Standard Model*,"
   Job interview seminar talk @ TDLI, SJTU, Shanghai, China, April 26, 2018
3. "*Future Opportunities in Neutrino Physics*," [slides]
   Seminar, Hongo High Energy Physics Theory Group, University of Tokyo, Japan, January 29, 2018
4. "*Leptonic Dirac CP Phase with Residual Symmetries & μDAR*," [slides]
   Seminar, Kobayashi-Maskawa Institute for the Origin of Particles and the Universe, Nagoya University, Japan, December 18, 2017
5. "*Leptonic Dirac CP Phase with Residual Symmetries & μDAR*," [announcement slides]
   APEC Seminar, Kavli IPMU, University of Tokyo, Japan, November 1, 2017
6. "*The Leptonic Dirac & Majorana CP Phases*," [announcement]
   Seminar, INPAC of SJTU, Shanghai, China, September 19, 2017
7. "*The Leptonic CP Phases*," [announcement, slides]
   Seminar, Laboratoire de Physique Subatomique et de Cosmologie (LPSC), Grenoble, France, May 22, 2017
8. "*The Leptonic CP Phases*," [announcement, slides]
   Seminar, Laboratoire de Physique de Clermont (LPC), Clermont-Ferrand, France, May 19, 2017
9. "*Opportunities in Atmospheric Neutrino Physics*," [slides]
   Seminar, Laboratoire Astroparticule & Cosmologie (APC), Universite Paris 7, Paris, France, May 18, 2017
10. "*Leptonic Dirac CP Phase with Residual Symmetries & μDAR*,"
    Seminar, Karlsruhe Institute of Technology, Germany, December 8, 2016
11. "*The Detection of Cosmic Neutrino Background and Its Phenomenological Consequences*,"
    Journal Club, Max-Planck-Institut für Kernphysik, Germany, November 18, 2016
12. "*The Leptonic Dirac CP Phase from Residual Symmetry and Muon Decay at Rest Experiment*," [announcement] [slides]
    Seminar, Center for Mathematical Sciences, University of Cambridge, UK, October 21, 2016
13. "*The Leptonic Dirac CP Phase from Residual Symmetry and Muon Decay at Rest Experiment*,"
    Seminar, Theory Division, Institute of High Energy Physics, Beijing, July 25, 2016

14. "*Measuring the Leptonic Dirac CP Phase with Muon Decay at Rest*,"
North China Electric Power University, Beijing, July 16, 2016
15. "*Measuring the Leptonic Dirac CP Phase with Muon Decay at Rest*,"
Academy Forum, Center for High Energy Physics, Tsinghua University, Beijing, July 14, 2016
16. "*Neutrino Dirac CP Phase with Residual Symmetries and* μ*DAR*,"
Seminar, Johannes Gutenberg University Mainz Theoretical High Energy Physics (THEP), Mainz, Germany, June 21, 2016
17. "*Neutrino Dirac CP Phase with Residual Symmetries and* μ*DAR Experiments*,"
Seminar, Nankai University, Tianjin, China, March 31, 2016
18. "*Neutrino Dirac CP Phase with Residual Symmetries and* μ*DAR Experiments*,"
Seminar, Shanghai Jiao Tong University (SJTU), Shanghai, China, January 5, 2016
19. "*Possible Extensions of JUNO – CP and Effect on* $0\nu2\beta$ *Decay*,"
Seminar, East China University of Science and Technology, Shanghai, China, January 4, 2016
20. "*Neutrino Dirac CP Phase with Residual Symmetries and* μ*DAR Experiments*,"
Seminar, TU Dortmund, Germany, December 3, 2015
21. "*Neutrino Dirac CP Phase with Residual Symmetries and* μ*DAR Experiments*,"
Seminar, IFIC, Valencia, Spain, November 18, 2015
22. "*The Physics Extensions of JUNO – CP and Effect on* $0\nu2\beta$ *Decay*,"
Seminar, Sun Yat-Sen University, Guangzhou, China, August 18, 2015
23. "*Higgs Physics at CEPC*,"
Seminar, Sun Yat-Sen University, Guangzhou, China, August 17, 2015
24. "*The Georgi Algorithms of Jet Clustering*,"
Seminar, Sun Yat-Sen University, Guangzhou, China, August 17, 2015
25. "*The Georgi Algorithms of Jet Clustering and Connections with Parton Shower*,"
Journal Club, Max-Planck-Institute für Kernphysik, Heidelberg, Germany, June 19, 2015
26. "*Precision Measurement of Higgs Couplings at CEPC*",
Mini-Workshop, Center for High Energy Physics, Peking University, Beijing, June 4, 2015
27. "*The Georgi Algorithms of Jet Clustering*",
Academy Forum, Center for High Energy Physics, Tsinghua University, Beijing, June 2, 2015
28. "*Basics of Parton Shower*",
Journal Club, Max-Planck-Institute für Kernphysik, Heidelberg, Germany, May 8, 2015

29. "*Effect of Gravitational Focusing on Annual Modulation in Dark Matter Direct Detection Experiments*",
    Journal Club, Max-Planck-Institute für Kernphysik, Heidelberg, Germany, April 17, 2015
30. "*Residual $\mathbb{Z}_2$ Symmetries and Experimental Test*",
    Particle and Astroparticle Theory Seminar, Max-Planck-Institute for Kernphysik, Heidelberg, Germany, November 10, 2014
31. "*Residual Symmetries and Fermion Mixings*",
    KEK Theory Center, Tsukuba, Japan, June 23, 2014
32. "*Decomposing Neutrino Oscillation in the Propagation Basis*",
    Center for High Energy Physics, Tsinghua University, Beijing, China, December 31, 2013
33. "*Phenomenology of Atmospheric Neutrino Oscillations with PINGU*",
    KEK, Japan, June 28, 2013
34. "*Determination of Neutrino Mass Hierarchy with Medium Baseline Reactor Neutrino Experiments*",
    Physics Department, Michigan State University, Michigan, USA, February 21, 2013
35. "*Phenomenology of Atmospheric Neutrino Oscillations with PINGU*",
    Physics Department, Michigan State University, Michigan, USA, February 19, 2013
36. "*Residual $\mathbb{Z}_2^s$ and $\overline{\mathbb{Z}}_2^s$ Symmetry Supported by Large θ_{13} and Nearly Maximal δ_D*",
    Physics Department, Peking University, Beijing, China, November 8, 2011
37. "*Beyond Tribimaximal Mixing*",
    Physics Department, University of Texas at Austin, Texas, USA, October 10, 2009
38. "*Current Status of Particle Physics*",
    University of Science and Technology Beijing (USTB), Beijing, China, January 7, 2009

16. Invited Academic Visits

1. Center for Neutrino Physics, Virginia Tech, Blacksburg, Virginia, USA, August 19-25, 2018, by Patrick Huber
2. Fermilab, Batavia, Illinois, USA, June 19 - September 17, 2018, by Neutrino Physics Center [NPC Fellowship]
3. T.D.Lee Institute (TDLI) at SJTU, Shanghai, China, May 16-21, 2018, by Hong-Jian He [to accompany Tsutomu Yanagida for job interview]
4. T.D.Lee Institute (TDLI) at SJTU, Shanghai, China, April 21 - May 6, 2018, by Hong-Jian He [job interview]

5. T.D.Lee Institute (TDLI) at SJTU, Shanghai, China, Januaray 3-5, 2018, by Hong-Jian He
6. Kobayashi-Maskawa Institute for the Origin of Particles and the Universe, Nagoya, Japan, December 16-20, 2017, by Masaharu Tanabashi
7. Center for High Energy Physics at Tsinghua University (TUHEP), Beijing, China, September 26 - October 14, 2017, by Hong-Jian He
8. T.D.Lee Institute (TDLI) at SJTU, Shanghai, China, September 15-19, 2017, by Hong-Jian He
9. Laboratoire de Physique Subatomique et de Cosmologie (LPSC), Grenoble, France, May 21-23, 2017, by Kentarow Mawatari
10. Laboratoire de Physique de Clermont (LPC), Clermont-Ferrand, France, May 18 - 21, 2017, by Jean Orloff and Ana Teixeira
11. Laboratoire Astroparticule & Cosmologie (APC), Universite Paris 7, Paris, France, May 17 - 18, 2017, by Antoine Kouchner
12. Center for Cosmology, Particle Physics and Phenomenology (CP3), Universite Catholique de Louvain, Belgium, February 7-10, 2017, by Fabio Maltoni and Kaoru Hagiwara
13. University of Cambridge, UK, October 20 - 22, 2016, by Tevong You
14. Tsinghua University, Beijing, China, June 26 - July 31, 2016, by Hong-Jian He
15. Nankai University, Tianjin, China, March 31 - April 3, 2016, by Xue-Qian Li and Yi Liao
16. Institute of High Energy Physics (IHEP), Beijing, China, March 25-27, 2016, by Manqi Ruan
17. Sun Yat-Sen University, Guangzhou, China, January 29-31, 2016, by Hong-Hao Zhang
18. Shanghai Jiaotong University, Shanghai, China, January 4-5, 2016, by Xiang-Dong Ji and Xiao-Gang He [job interview]
19. East China University of Science and Technology, Shanghai, China, January 4, 2016, by Wei Liao
20. Tsinghua University, Beijing, China, December 22-30, 2015, by Hong-Jian He
21. CERN Theory Division, Geneva, Switzerland, December 8-11, 2015, by Matthew McCullough
22. TU Dortmund, Germany, December 2-4, 2015, by Heinrich Päs
23. IFIC, Valencia, Spain, November 11-20, 2015, by Jose Valle
24. Tsinghua University, Beijing, China, August 19-26, 2015, by Hong-Jian He
25. Sun Yat-Sen University, Guangzhou, China, August 15-18, 2015, by Hong-Hao Zhang

26. Tsinghua University, Beijing, China, August 13-14, 2015, by Hong-Jian He
27. Center for High Energy Physics, Peking University, Beijing, China, June 4, 2015, by Qiang Li and Qi-Shu Yan (Kaoru's Visit)
28. Tsinghua University, Beijing, China, May 17 - June 7, 2015, by Hong-Jian He
29. MPIK, Heidelberg, Germany, July 13-20, 2014, by Manfred Lindner
30. Ohio State University, Columbia, Ohio, USA, February, 2013 by Carsten Rott
31. Michigan State University (MSU), East Lansing, Michigan, USA, February, 2013 by Wayne Repko
32. Pittsburg University, Pittsburg, USA, February 7-11, 2013 by Tao Han

17. List of References

- **John Ellis**
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  King's College London, UK
  Royal Society Fellow (英国皇家学会院士)
  Winner of Maxwell Medal (麦克斯韦奖, 1982) & Dirac Medal (狄拉克奖, 2005)
  Email: john.ellis@cern.ch

- **Alexei Smirnov**
  Professor, Max-Planck-Institut (马克斯·普朗克研究所), Heidelberg, Germany
  Winner of APS Sakurai Prize (2008) and Einstein Medal (爱因斯坦奖章, 2016)
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- **Tsutomu Yanagida**
  Professor, Kavli IPMU, University of Tokyo, Japan
  Member of the Academy of Science and Humanities in Hamburg (德国汉堡科学与人文学院院士)
  Winner of Nishinomiya-Yukawa Prize (1988), Nishina Memorial Prize (1992), Humboldt Research Award (2003), Totsuka Youji Prize (2012), and Helmholtz International Fellow Award (2015). The inventor of Seesaw Mechanism & Leptogenesis Mechanism.
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