Shengdu Chai

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EDUCATION

- **Fudan University** — Shanghai, China
  Bachelor of Science with Honors in Physics; — *Sept. 2019 - June. 2024*
  GPA(Overall): 3.68/4.0 (Rank: 7/131); **GPA(Major):** 3.87; **H:** Honored courses;
  Core Coursework: C Programming, Deep Learning, Classical Mechanics(H), Methods of Mathematical Physics A(H), Thermodynamics and Statistical Physics I, Quantum Mechanics I, Solid State Physics(H), Classical Electrodynamics, Group Theory
  Graduate-Level Coursework: Particle Physics, Quantum Field Theory, Gauge Theory, Quantum Computation and Quantum Information, Thermodynamics and Statistical Physics II

- **Peking University** — Beijing, China
  Summer Program in School of Physics — *Aug.2021 – Aug.2021*
  Topics covered: Particle Physics, Cosmology, Dark Matter and Quantum Field Theory

- **University of Chicago** — Chicago, IL, US
  Non-Degree Visiting Students Program — *July 2022 – Sept.2022*
  Supervisor: Lian-Tao Wang, Professor

- **Fudan University** — Shanghai, China
  PhD student in Condensed Matter Theory — *Sept. 2024 - present*
  Supervisor: Xincheng Xie, Professor

PUBLICATIONS

- "Measurement of the Chern number for non-Hermitian Chern insulators", Hongfang Liu, Ming Lu, **Shengdu Chai**, Zhi-Qiang Zhang, Hua Jiang, PRB

- "From optimal observables to machine learning: an effective-field-theory analysis of $e^+e^- \to W^+W^-$ at future lepton colliders", **Shengdu Chai**, Jiayin Gu, Lingfeng Li, JHEP

- "Accommodating the CDF W-boson mass measurement in the beautiful mirror model", **Shengdu Chai**, Jiayin Gu, Lian-Tao Wang, PRD

RESEARCH EXPERIENCE

- **Explanation of New CDF W Mass** — University of Chicago
  Research Assistant to Professor Lian-Tao Wang — *July 2022 – Sept.2022*

  - Explained both the new W boson mass $m_W^{\mathrm{CDF-II}}$ reported by Fermi Lab and the long existed discrepancy of forward-backward asymmetry $A_{FB}^{0,b}$ by introducing new vector-like quarks

  - Explored the model properties by performing a global electroweak fit. Found that the model is consistent with the current direct-search limits at the LHC, the HL-LHC, can cover most of the regions of the parameter space preferred by the electroweak fit. Determined that the one-loop contribution to Higgs couplings in this model was also relevant, which is consistent on current measurement and may be excluded on future collider

  - Determined that the mass of the exotic quark (with charge $-4/3$) is required to be below 4 TeV at the 95% confidence level, and the best-fit point corresponded to a mass of around 1.5 TeV

- **Machine Learning in SMEFT** — Fudan University
  Research Assistant to Associate Professor Jiayin Gu — *Jun.2022 - Jan.2024*

  - Aimed to apply machine learning techniques to the phenomenological analyses of the Standard Model Effective Field Theory (SMEFT), focusing on the measurements at future lepton colliders

  - Performed machine learning methods with simulations of $e^+e^- \to W^+W^-$, including some systematic effects to determine the likelihood ratio in terms of the Wilson coefficients of dimension-six operators in this process.

  - Determined that the machine learning method performed better than the traditional methods, such as Optimal Observable, which corrected the large bias of model parameters and gave strong constraints

  - Found the bias has a scaling law with the number of training samples, with more training samples, the bias can be reduced to a negligible level

Course Projects

- **Tensor Network Renormalization for Anisotropic Ising Model** — Fudan University
  Course Project advised by Professor Yang Qi — *Oct.2021 - Dec.2021*
  - Studied the anisotropic Ising model by calculating the partition function using tensor network renormalization (TNR)
  - Obtained the specific heat, spontaneous susceptibility, and critical temperature of this system
  - Found that with higher bond dimension one can get better results from TNR. Our results also implied that for anisotropic models, TNR cannot give as good results as for isotropic models.

- **Nonlinear Differential Equations and Chaos** — Fudan University
  Course Project advised by Associate Professor Yang Zhou — *Mar.2021 - Jun.2021*
  - Elucidated the relationship between nonlinear differential equations and chaos and found a way to describe quantum chaos
  - Simulated the Chua's Circuit by Mathematica to generalize the characteristic of Nonlinear Differential Equations and Classical Chaos
  - Calculated the Spectral Form Factor of the Gaussian unitary ensemble (GUE), one of the ensembles of Random Matrix Theory (RMT), which can be a signature of Quantum Chaos

Talks and Seminars

- **Invited Talks**
  - Probing BSM effects in $e^+e^- \to WW$ with machine learning
    - HKUST ias — *Oct.2022*

- **Contributed Talks**
  - **IHEP** Workshop on the High Energy Circular Electron Positron Collider
    https://indico.ihep.ac.cn/event/17020/contributions/119266/ — *Oct.2022*
  - **HKUST ias** IAS Program on High Energy Physics
    https://indico.cern.ch/event/1215937/timetable/20230212.detailed — *Feb.2023*

- **Posters**
  - **BIMSA** The first International Congress of Basic Science (ICBS)
    https://www.icbs.cn/en/web/index/18009 — *July.2023*

Honors And Awards

- **Outstanding Graduate of Fudan University**(top 10%) — *Jun.2024*
- **Bachelor of Science with Honors**(top 5%) — *Jun.2024*
- **Fudan University Undergraduate Professional Scholarship** — *Oct.2022*
- **Honors Student in Department of Physics** — *Oct.2022*
- **Fudan University Undergraduate Professional Scholarship** — *Oct.2021*
- **Honors Student in Department of Physics** — *Oct.2021*
- **1st Prize in Fudan University Scholarship for Outstanding Students**(top 4 in the Department) — *Sept.2021*
- **Outstanding Student in Fudan University** — *Oct.2020*
- **2nd Prize of China Undergraduate Physics Tournament**,a team-oriented physics competition between 60 top universities in China — *Oct.2020*
- **1st Prize in Fudan University Scholarship for Outstanding Students**(top 5 in the Department) — *Sept.2020*
- **2nd Prize of 2020 Mathematical Contest in Modeling** ,
  a team-oriented competition of math modeling — *Sept.2020*
- **Outstanding Student in Fudan University** — *May.2020*

Skills Summary

- **Programming Skills**: Python (proficient), C/C++, pytorch, Mathematica, jax
- **Computer Skills**: Latex, Machine Learning, COMSOL, Root, MadGraph 5, Delphes