

# Kairui Zhang, PhD

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## Research Positions

- 2024/9 – current       **Postdoctoral Research Fellow**, Department of Physics and Astronomy, University of Oklahoma
- 2024/5 – 2024/9       **Visiting Scholar**, Department of Physics and Astronomy, University of Nebraska-Lincoln
- 2019/9 – 2023/12       **Graduate Research Assistant**, Department of Physics, University of Wisconsin-Madison
- 2014/5 – 2017/5       **Undergraduate Research Assistant**, Department of Physics, University of Illinois at Urbana-Champaign

## Education

- 2019/9 – 2023/12       **Ph.D. in Physics, University of Wisconsin-Madison.**  
Thesis: *"Naturalness Demands an Answer: The Imperative of Natural SUSY at the HL-LHC"*  
Advisor: Vernon D. Barger
- 2017/9 – 2019/9       **Master in Physics, University of Wisconsin-Madison.**  
Advisor: Vernon D. Barger
- 2013/9 – 2017/5       **B.S., Physics, University of Illinois at Urbana-Champaign**  
Advisor: Benjamin H. Hooberman
-  **B.S., Mathematics, University of Illinois at Urbana-Champaign**

## Research Interests

**Theoretical Particle physics, Particle Phenomenology, & Cosmology** – broadly on physics beyond the Standard Model (BSM) – including 1) Aspects of Electroweak Symmetry Breaking, 2) Flavor & Horizontal Symmetries, 3) Baryogenesis Mechanism & Dark Matter, 4) Supersymmetry under String Landscapes, 5) Axion Physics & the Strong CP Problem, 6) Formal aspects of Quantum Field Theory, as well as the 7) Experimental and observational phenomenology of various BSM extensions.

## Publications

**Note:** Following HEP convention, order of authorship was determined alphabetically.

### Preprints

-  H. Baer, V. Barger, J. Bolich, D. Sengupta, and K. Zhang, “Natural supersymmetry at a muon collider”, (*under review in Phys. Rev. D*) (2025), arXiv:2510.20920 [hep-ph].

- 2 S. P. Adhya et al. (CEPC Study Group), “CEPC Technical Design Report - Reference Detector”, (2025), arXiv:2510.05260 [hep-ex].

## Journal Articles

- 3 H. Baer, V. Barger, J. Bolich, D. Sengupta, and K. Zhang, “Aspects of the WIMP quality problem and R-parity violation in natural supersymmetry with all axion dark matter”, JCAP **10**, 072 (2025) [10.1088/1475-7516/2025/10/072](#), arXiv:2505.09785 [hep-ph].
- 4 H. Baer, V. Barger, J. Bolich, J. Dutta, D. Martinez, S. Salam, D. Sengupta, and K. Zhang, “Prospects for supersymmetry at High-Luminosity LHC”, Rev. Mod. Phys. **97**, 045001 (2025) [10.1103/bzw1-gfs1](#), arXiv:2502.10879 [hep-ph].
- 5 H. Baer, V. Barger, D. Sengupta, and K. Zhang, “All axion dark matter from supersymmetric models”, Phys. Rev. D **111**, L111702 (2025) [10.1103/1n3m-g69m](#), arXiv:2502.06955 [hep-ph].
- 6 H. Baer, V. Barger, J. Bolich, and K. Zhang, “Implications of Higgs mass for hidden sector SUSY breaking”, Phys. Rev. D **111**, 095019 (2025) [10.1103/PhysRevD.111.095019](#), arXiv:2412.15356 [hep-ph].
- 7 P. Huang and K. Zhang, “Testable flavored TeV-scale resonant leptogenesis with MeV-GeV dark matter in a neutrinophilic two-Higgs-doublet model”, Phys. Rev. D **111**, 115011 (2025) [10.1103/b5sk-5f3d](#), arXiv:2411.18973 [hep-ph].
- 8 H. Baer, V. Barger, and K. Zhang, “Living dangerously with decoupled first and second generation scalars: SUSY prospects at the LHC”, Phys. Rev. D **111**, 035033 (2025) [10.1103/PhysRevD.111.035033](#), arXiv:2411.13541 [hep-ph].
- 9 H. Baer, V. Barger, and K. Zhang, “Decoding the gaugino code, naturally, at high-lumi LHC”, Particles **7**, 927 (2024) [10.3390/particles7040056](#), arXiv:2408.02048 [hep-ph].
- 10 H. Baer, V. Barger, and K. Zhang, “Stau pairs from natural SUSY at high luminosity LHC”, Phys. Rev. D **110**, 015017 (2024) [10.1103/PhysRevD.110.015017](#), arXiv:2403.18991 [hep-ph].
- 11 H. Baer, V. Barger, X. Tata, and K. Zhang, “Winos from natural SUSY at the high luminosity LHC”, Phys. Rev. D **109**, 015027 (2024) [10.1103/PhysRevD.109.015027](#), arXiv:2310.10829 [hep-ph].
- 12 H. Baer, V. Barger, J. Dutta, D. Sengupta, and K. Zhang, “Top squarks from the landscape at high luminosity LHC”, Phys. Rev. D **108**, 075027 (2023) [10.1103/PhysRevD.108.075027](#), arXiv:2307.08067 [hep-ph].
- 13 H. Baer, V. Barger, X. Tata, and K. Zhang, “Prospects for Charged Higgs Bosons in Natural SUSY Models at the High-Luminosity LHC”, Symmetry **15**, (Selected to be the Journal Cover), 1475 (2023) [10.3390/sym15081475](#), arXiv:2306.05207 [hep-ph].
- 14 H. Baer, V. Barger, X. Tata, and K. Zhang, “Detecting Heavy Neutral SUSY Higgs Bosons Decaying to Sparticles at the High-Luminosity LHC”, Symmetry **15**, 548 (2023) [10.3390/sym15020548](#), arXiv:2212.09198 [hep-ph].
- 15 H. Baer, V. Barger, X. Tata, and K. Zhang, “Prospects for Heavy Neutral SUSY HIGGS Scalars in the hMSSM and Natural SUSY at LHC Upgrades”, Symmetry **14**, 2061 (2022) [10.3390/sym14102061](#), arXiv:2209.00063 [hep-ph].

## In Preparation

- 16 H. Baer, V. Barger, X. Tata, and K. Zhang, “Naturalness, Gaugino Mass Unification, and pMSSM”, (2025), arXiv:2512.xxxxx [hep-ph].
- 17 K. Zhang, “Baryon Asymmetry, Relic Abundance, Neutrino Mass in One Shot”, (2025), arXiv:2512.xxxxx [hep-ph].
- 18 P. Huang and K. Zhang, “Collider Phenomenology of the Neutrinophilic Type-I Two-Higgs-Doublet Model with TeV-Scale Flavored Leptogenesis”, (2026), arXiv:2601.xxxxx [hep-ph].
- 19 K. Zhang, “The Implication of Electroweak Symmetry Restoration and Radiation Amplitude Zeros on Probing Extended Higgs Sectors”, (2026), arXiv:2601.xxxxx [hep-ph].

## Thesis

- 20 K. Zhang, “Naturalness demands an answer: the imperative of natural SUSY at the HL-LHC”, PhD thesis (Wisconsin U., Madison, 2023).

## Talks & Oral Presentations

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**Note:** † are invited talks.

- *"Axion quality problem, WIMP quality problem, and R-parity violation in supersymmetry"*,  
 Axion in Cosmology, Kavli IPMU, Japan, Nov 2025.
- *"Flavored Leptogenesis with MeV–GeV Dark Matter"*,  
 2nd International Conference on the Physics of the Two Infinities, University of Tokyo, Japan, Nov 2025.
- *"Baryon Asymmetry, Relic Abundance, and Neutrino Mass in One Shot"†*,  
 High Energy Physics Seminar, University of Pittsburgh, US, Nov 2025.
- *"Axion quality problem, WIMP quality problem, and R-parity violation in natural supersymmetry"*,  
 28th International Conference on Particle Physics & Cosmology (COSMO-25), Carnegie Mellon University, US, Oct 2025.
- *"SUSY prospects at the HL-LHC"†*,  
 32nd International Symposium on Lepton Photon Interactions at High Energies (Lepton-Photon 2025), University of Wisconsin-Madison, US, Aug 2025.
- *"Axion quality problem, WIMP quality problem, and R-parity violation in natural supersymmetry"*,  
 32nd International Conference on Supersymmetry and Unification of Fundamental Interactions (SUSY 2025), University of Santa Cruz, US, Aug 2025.
- *"Flavored Leptogenesis with MeV–GeV Dark Matter"*,  
 32nd International Conference on Supersymmetry and Unification of Fundamental Interactions (SUSY 2025), University of Santa Cruz, US, Aug 2025.
- *"Flavored TeV-scale Resonant Leptogenesis with MeV–GeV Dark Matter"*,  
 Phenomenology 2025 Symposium, University of Pittsburgh, US, May 2025.

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*"Flavored Resonant Leptogenesis in a Type-I Two Higgs Doublet Model"*,  
 Particle Physics on the Plains 2024, University of Kansas, US, Nov 2024.
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*"Top squarks from the landscape at high luminosity LHC"*,  
 The 31st International Conference on Supersymmetry and Unification of Fundamental Interactions (SUSY 2024), IFT, Madrid, Spain, June 2024.
- 
*"Winos from natural SUSY at the high luminosity LHC"*,  
 APS Division of Particles & Fields (DPF) Meeting – Phenomenology 2024 Joint Symposium, University of Pittsburgh, US, May 2024.
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*"Implications of Naturalness for Heavy SUSY Particle Discovery at the HL-LHC Era"<sup>†</sup>*,  
 High Energy Physics Seminar, University of Oklahoma, US, Oct 2023.
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*"Prospects of Heavy Higgs scalar in the natural SUSY at LHC upgrades"*,  
 Brookhaven Forum 2023 Advancing Searches for New Physics, Brookhaven National Lab, US, Oct 2023.
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*"Heavy Higgs scalar in the natural SUSY at LHC upgrades"*,  
 The 30th International Conference on Supersymmetry and Unification of Fundamental Interactions (SUSY 2023), University of Southampton, Southampton, UK, July 2023.
- 
*"Prospects of Heavy Higgs scalar in the natural SUSY at LHC upgrades"*,  
 Phenomenology 2023 Symposium, University of Pittsburgh, US, May 2023.
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*"Top  $p_T$  Reweighting in ATLAS"*,  
 ATLAS SUSY Strong Production with 2 Leptons Meeting, ATLAS, CERN, Oct 2016.

## Other Workshops & Schools Attendee

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|---------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| December 2025 |  | <i>Dark matter and black holes Workshop</i> ,<br>Kavli IPMU, Japan.                                |
| November 2025 |  | <i>Particle Physics on the Plains 2025</i> ,<br>University of Kansas, US.                          |
| August 2025   |  | <i>Pre-SUSY School 2025</i> ,<br>University of California – Santa Cruz, US.                        |
| July 2025     |  | <i>53rd SLAC summer institute (SSI 2025)</i> ,<br>SLAC, US.                                        |
| June 2025     |  | <i>Phenomenology Before and After the Standard Model</i> ,<br>University of Wisconsin-Madison, US. |
| August 2019   |  | <i>12th International Neutrino Summer School at Fermilab</i> ,<br>Fermilab, US.                    |

## Other Academic Contributions

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**Solutions Manual** for “*Quantum Field Theory and the Standard Model*” by Matthew D. Schwartz
  - First 19 chapters + appendices; complete solutions with detailed steps for all exercises.

- Used as a reference when mentoring graduate students.
- Available online at my personal webpage.



### **Solutions Manual** for “Cosmology” by Daniel Baumann

- First 3 chapters + appendices; complete solutions with detailed steps for all exercises.
- Used as a reference when mentoring graduate students.
- Available online at my personal webpage.

## **Technical Skills**

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|-----------------------------|----------------------------------------------------------------------------------------------|
| Programming Languages       | ☀ C++, C, Fortran, Java, Matlab, Mathematica, Python.                                        |
| Machine Learning Frameworks | ☀ PyTorch, TensorFlow.                                                                       |
| Machine Learning Algorithms | ☀ Convolutional neural network, Decision tree, Random forest, LSTM.                          |
| Physics Analysis Packages   | ☀ Delphes, Fastjet, Flavio, Isajet, MadGraph, Prospino, Pythia, Root, SOFUSUSY, SusHi, zHDMC |

## **Teachings & Grading**

- PHYS 832 – “Advanced Quantum Mechanics II (Graduate-level Quantum Field Theory II)”:  
*Grader, Spring 2023*
- PHYS 831 – “Advanced Quantum Mechanics I (Graduate-level Quantum Field Theory I)”:  
*Grader, Fall 2023*
- PHYS 721 – “Theoretical Physics-Electrodynamics (Graduate-level)”:  
*Grader, Fall 2023*
- PHYS 531 – “Introduction to Quantum Mechanics I (Graduate-level)”:  
*Grader, Spring 2019*
- PHYS 449 – “Atomic and Quantum Physics II”:  
*Grader, Spring 2020*
- PHYS 415 – “Thermal Physics”:  
*Grader, Spring 2022*
- PHYS 406 – “Special Topics in Physics (Intro to General Relativity & Cosmology)”:  
*Grader, Fall 2019*
- PHYS 308 – “Lab-Electromagnetic Fields and Optics”:  
*Teaching assistant, Spring 2018*
- PHYS 307 – “Lab-Mechanics & Modern Physics”:  
*Teaching assistant, Fall 2017, Fall 2018, Spring 2019*
- PHYS 115 – “Energy”:  
*Teaching assistant, Fall 2019, Fall 2023*

- PHYS 109 – “Physics in the Arts”:

*Teaching assistant, Spring 2020, Fall 2020, Spring 2021, Fall 2021, Spring 2023*

## **Past Experimental Collaborations**

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2014/5 – 2017/5      **ATLAS Collaboration**, *Undergraduate Researcher.*