Stanford



Chao-Lin Kuo

Professor of Physics and of Particle Physics and Astrophysics

Bio

BIO

My research explores fundamental questions about the universe: How did the universe begin? What is the nature of dark matter, which accounts for about 85% of the universe's total mass? To address these questions, my group develops new experimental techniques and detector technologies, including quantum-enhanced detectors, to search for signals that would otherwise be extremely difficult to measure.

Cosmology and primordial gravitational waves: My group works on experiments at the South Pole, including BICEP and SPT, that study the cosmic microwave background (CMB), the faint afterglow of the Big Bang. By measuring its polarization, we aim to find evidence of primordial gravitational waves, which could provide a window into the earliest moments of the universe.

Axion dark matter searches: Through ADMX-VERA, my group develops new types of detectors to search for axions, one of the most compelling candidates for dark matter. These experiments use microwave detectors with novel geometries to convert potential axion signals into measurable electromagnetic signals.

Quantum-enhanced detectors: My group develops quantum-enhanced detectors and measurement techniques to improve the sensitivity of searches for dark matter and to explore applications in cosmology and other areas of physics.

These research areas bring together fundamental questions about the universe with experimental physics, astrophysics, and quantum measurement.

I received my PhD from UC Berkeley and did a postdoc at Caltech before arriving at Stanford in 2008.

ACADEMIC APPOINTMENTS

- Professor, Physics
- Professor, Particle Physics and Astrophysics

HONORS AND AWARDS

- Early Career Award, NSF (2011)
- Alfred P. Sloan Fellowship, Sloan Foundation (2009)

PROFESSIONAL EDUCATION

- Ph.D., UC Berkeley , Astrophysics (2003)

- B.Sc., National Taiwan University , Physics (1994)

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

My research explores fundamental questions about the universe: How did the universe begin? What is the nature of dark matter, which accounts for about 85% of the universe's total mass? To address these questions, my group develops new experimental techniques and detector technologies, including quantum-enhanced detectors, to search for signals that would otherwise be extremely difficult to measure.

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Teaching

COURSES

2026-27

- Classical Electrodynamics: PHYSICS 220 (Win)

2025-26

- Classical Electrodynamics: PHYSICS 220 (Win)

2024-25

- Classical Electrodynamics: PHYSICS 220 (Win)

2023-24

- Advanced Mechanics: PHYSICS 110, PHYSICS 210 (Aut)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Jason Corbin, Pamela Stark

Postdoctoral Faculty Sponsor

Kyle Kennard, Baibhav Singari, Osmond Wen

Doctoral Dissertation Advisor (AC)

Daniel Campos, Taj Dyson, Yuka Nakato, Sephora Ruppert, Zoe Smith, Matt Withers

Doctoral (Program)

Naija Bruckner, Chang Cheng, Joseph Curti, Andrea Gaspert, Ryan Hwangbo, Giulia Murgia, Sirina Prasad, Cady van Assendelft

Publications

PUBLICATIONS

- **Maximizing quantum enhancement in axion dark matter experiments** *PHYSICAL REVIEW D*
  Kuo, C., Bartram, C. L., Chou, A. S., Dyson, T. A., Kurinsky, N. A., Rybka, G., Ruppert, S., Wen, O., Withers, M. O., Yi, A. K., Zhang, C.
  2025; 111 (12)
- **Beehive haloscope for high-mass axion dark matter** *PHYSICAL REVIEW D*
  Withers, M. O., Kuo, C.
  2025; 111 (7)
- **High-volume tunable resonator for axion searches above 7 GHz** *PHYSICAL REVIEW APPLIED*
  Dyson, T. A., Bartram, C. L., Davidson, A., Ezekiel, J. B., Futamura, L. M., Liu, T., Kuo, C.
  2024; 21 (4)
- **Filamentary Dust Polarization and the Morphology of Neutral Hydrogen Structures** *ASTROPHYSICAL JOURNAL*
  Halal, G., Clark, S. E., Cukierman, A., Beck, D., Kuo, C.
  2024; 961 (1)
- **Laboratory Integration of the AliCPT-1 Receiver** *IEEE TRANSACTIONS ON APPLIED SUPERCONDUCTIVITY*
  Salatino, M., Withers, M. O., Kuo, C., Thompson, K. L., Austermann, J., Groh, J. C., Karpel, E. D., Mauskopf, P., Meinke, J., Montana-Lopez, J. A., Parker, C., Roberson, C., Weeks, et al
  2023; 33 (5)
- **SLAC microresonator RF (SMuRF) electronics: A tone-tracking readout system for superconducting microwave resonator arrays.** *The Review of scientific instruments*
  Yu, C., Ahmed, Z., Frisch, J. C., Henderson, S. W., Silva-Feaver, M., Arnold, K., Brown, D., Connors, J., Cukierman, A. J., D'Ewart, J. M., Dober, B. J., Dusatko, J. E., Haller, et al
  2023; 94 (1): 014712
- **Current Status of the Ali CMB Polarization Telescope Focal Plane Camera** *IEEE TRANSACTIONS ON APPLIED SUPERCONDUCTIVITY*
  Salatino, M., Austermann, J., Meinke, J., Sinclair, A. K., Walker, S., Bai, X., Beall, J., Connors, J., Dober, B., Duff, S. M., Givhan, R. C., Hilton, G., Hubmayr, et al
  2021; 31 (5)
- **Symmetrically tuned large-volume conic shell-cavities for axion searches** *Journal of Cosmology and Astroparticle Physics*
  Kuo, C.
  2021; February (02)
- **LiteBIRD satellite: JAXA's new strategic L-class mission for all-sky surveys of cosmic microwave background polarization**
  Hazumi, M., Ade, P. A., Adler, A., Allys, E., Arnold, K., Auguste, D., Aumont, J., Aurlien, R., Austermann, J., Baccigalupi, C., Banday, A. J., Banjeri, R., Barreiro, et al
  edited by Lystrup, M., Perrin, M. D., Batalha, N., Siegler, N., Tong, E. C.
  SPIE-INT SOC OPTICAL ENGINEERING.2021
- **Large-volume centimeter-wave cavities for axion searches** *Journal of Cosmology and Astroparticle Physics*
  Kuo, C.
  2020
- **Constraints on Primordial Gravitational Waves Using Planck, WMAP, and New BICEP2/Keck Observations through the 2015 Season** *PHYSICAL REVIEW LETTERS*
  Ade, P. R., Ahmed, Z., Aikin, R. W., Alexander, K. D., Barkats, D., Benton, S. J., Bischoff, C. A., Bock, J. J., Bowens-Rubin, R., Brevik, J. A., Buder, I., Bullock, E., Buza, et al
  2018; 121 (22)

- **Highly-multiplexed microwave SQUID readout using the SLAC Microresonator Radio Frequency (SMuRF) Electronics for Future CMB and Sub-millimeter Surveys**

  Henderson, S. W., Ahmed, Z., Austermann, J., Becker, D., Bennett, D. A., Brown, D., Chaudhuri, S., Cho, H., D'Ewart, J. M., Dober, B., Duff, S. M., Dusatko, J. E., Fatigoni, et al

  edited by Zmuidzinas, J., Gao

  SPIE-INT SOC OPTICAL ENGINEERING.2018

- **BICEP2 / Keck Array IX: New bounds on anisotropies of CMB polarization rotation and implications for axionlike particles and primordial magnetic fields** *PHYSICAL REVIEW D*

  Ade, P. R., Ahmed, Z., Aikin, R. W., Alexander, K. D., Barkats, D., Benton, S. J., Bischoff, C. A., Bock, J. J., Bowens-Rubin, R., Brevik, J. A., Buder, I., Bullock, E., Buza, et al

  2017; 96 (10)

- **BICEP2/KECK ARRAY VIII: MEASUREMENT OF GRAVITATIONAL LENSING FROM LARGE-SCALE B-MODE POLARIZATION** *ASTROPHYSICAL JOURNAL*

  Ade, P. A., Ahmed, Z., Aikin, R. W., Alexander, K. D., Barkats, D., Benton, S. J., BISCHOFF, C. A., Bock, J. J., Bowens-Rubin, R., Brevik, J. A., Buder, I., Bullock, E., Buza, et al

  2016; 833 (2)

- **BICEP2/KECK ARRAY. VII. MATRIX BASED E/B SEPARATION APPLIED TO BICEP2 AND THE KECK ARRAY** *ASTROPHYSICAL JOURNAL*

  Ade, P. A., Ahmed, Z., Aikin, R. W., Alexander, K. D., Barkats, D., Benton, S. J., BISCHOFF, C. A., Bock, J. J., Bowens-Rubin, R., Brevik, J. A., Buder, I., Bullock, E., Buza, et al

  2016; 825 (1)

- **Joint Analysis of BICEP2/Keck Array and Planck Data** *PHYSICAL REVIEW LETTERS*

  Ade, P. A., Aghanim, N., Ahmed, Z., Aikin, R. W., Alexander, K. D., Arnaud, M., Aumont, J., Baccigalupi, C., Banday, A. J., Barkats, D., Barreiro, R. B., Bartlett, J. G., Bartolo, et al

  2015; 114 (10)

- **Detection of B-Mode Polarization at Degree Angular Scales by BICEP2.** *Physical review letters*

  Ade, P. A., Aikin, R. W., Barkats, D., Benton, S. J., BISCHOFF, C. A., Bock, J. J., Brevik, J. A., Buder, I., Bullock, E., Dowell, C. D., Duband, L., Filippini, J. P., Fliescher, et al

  2014; 112 (24): 241101-?