Benjamin Knepper

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EDUCATION

University of California, Berkeley, College of Letters & Science — Berkeley, CA
Majors: Physics, Philosophy; *Minor:* Mathematics — 08/2023 - present
Physics GPA: 4.0/4.0 — B.A. in progress for 12/2025

Cornell University, College of Arts & Sciences — Ithaca, NY
Majors: Physics, Philosophy — 08/2020 - 05/2022
Cumulative GPA: 3.77/4.0

RESEARCH EXPERIENCE

UC Berkeley Physics Honors Bachelor's Thesis — Berkeley, CA
Theoretical Student Researcher — 03/2025 - current

- Calculating the "standard quantum limit" (SQL) of measuring the length of a Jackiw-Teitelboim gravity wormhole in the Hartle-Hawking state, using open quantum system linear response theory
- Identified the Sachdev-Ye-Kitaev (SYK) dual operator of wormhole length via chord diagrams and Krylov complexity in the triple-scaled limit, and now matching bulk-boundary correlation functions
- Developing both digital (qubit) and analog (cold atom cavity) experimental implementations

Advanced Quantum Testbed (AQT) — Berkeley, CA
Theoretical and Experimental Research Collaborator — 08/2024 - current

- Deriving a protocol to measure an effective "Page curve" in chaotic many-body quantum systems, relating quantum Fisher information with out-of-time-order correlators (OTOCs)
- Successfully wrote a research proposal to simulate this measurement on AQT superconducting qutrits, with information scrambling generated by pseudorandom unitaries
- Coding OTOC simulations in Google Cirq software for an experimental test underway in Fall 2025

Lawrence Berkeley National Laboratory (LBNL) — Berkeley, CA
QuIPS (Quantum Invisible Particle Sensor) Experiment Researcher — 11/2023 - current

- Collaborating on Geant4 Monte Carlo simulations of unique first-forbidden β- decays and analyses of signal-to-noise projections for the upcoming QuIPS beyond-standard-model search
- Designed an optimal configuration of particle physics calorimeters surrounding an optomechanically levitated nanosphere, achieving a QuIPS detector sensitivity to a sterile neutrino coupling of 10^{-3}

Network for Neutrinos, Nuclear Astrophysics, and Symmetries (N3AS) — Berkeley, CA
Theoretical Student Researcher — 08/2023 - 12/2023

- Initiated a phenomenological model to detect ultra-light dark matter from primordial black holes using asteroseismology and observations of oscillations in relativistic stars

University of Chicago Enrico Fermi Institute — Chicago, IL
UChicago Temporary Research Professional — 05/2023 - 08/20233

- Measured blackbody spectrum of the GigaBREAD experiment with a Vector Network Analyzer to determine system noise temperature, confirming sensitivity to $O(10)$ GHz resonant modes
- Performed Fourier signal analysis of the thermal noise which identified a contaminant background
- Wrote Python data acquisition scripts for the current best dark photon limit of 10^{-12} in [10.7, 12.5] GHz

Fermi National Accelerator Laboratory — Batavia, IL
D.O.E SULI (Science Undergraduate Laboratory Internships) Intern — 01/2023 - 05/2023

- Performed optical ray-tracing simulations in FRED software to characterize focusing errors of signal

photons onto a Superconducting Nanowire Single Photon Detector (SNSPD) in InfraBREAD
- Designed a novel photon detector configuration involving a Winston Cone and reflector optics that improves quantum sensing efficiency by 55%, even with misalignments from cryogenic cooling

Millennium Institute of Astrophysics Santiago, Chile
Research Assistant 06/2022 - 09/2022

- Modeled the transit photometry and radial velocity data of a NASA TESS exoplanet candidate in Python, leading to the verification of the novel warm jupiter planet TOI-6628b
- Coded with Bayesian parameter optimization algorithms such as Markov Chain Monte Carlo (MCMC)

PUBLICATIONS

Peer Reviewed:
1. G. Hoshino et al. (GigaBREAD Collaboration), "First Axion-Like Particle Results from a Broadband Search for Wave-Like Dark Matter in the 44 to 52 μeV Range with a Coaxial Dish Antenna," *Phys.Rev.Lett. 134 171002* (2025).
2. M. Tala Pinto et al., "Three Warm Jupiters and one sub-Saturn orbiting TOI-6628, TOI-3837, TOI-5027 and TOI-2328," *Astronomy & Astrophysics 694 A268* (2025).
3. S. Knirck et al. (BREAD Collaboration), "First Results from a Broadband Search for Dark Photon Dark Matter in the 44 to 52 μeV Range with a Coaxial Dish Antenna", *Phys.Rev.Lett. 132 131004* (2024), *Editor's Suggestion.*

Manuscripts:
4. B. Knepper, A. Sonnenschein, S. Knirck, "Focusing Optics for Axion Detection: Simulating Sensing Enhancements of Photons in InfraBREAD," *OSTI 2377355* (2024).

HONORS & AWARDS

- Recipient of the national 2024 American Institute of Physics, Society of Physics Students "Outstanding Undergraduate Research Award", $500

SELECT CONFERENCES & WORKSHOPS

- 2025 Quantum Sensing and Precision Science Summer School, Johns Hopkins, MD — *participant*
- 2025 APS Global Summit March-April Meeting, Anaheim, CA — *talk*
- 2025 Observables in Quantum Gravity: From Theory to Experiment, Aspen Center for Physics, CO — *poster presentation*
- 2024 Vienna Quantum Foundations Conference, Institute for Quantum Optics and Quantum Information (IQOQI), Vienna, Austria — *poster presentation*
- 2023 SQMS Annual Ecosystem Day Collaboration Meeting, Fermilab, IL — *poster presentation*
- 2023 U.S. QIS Summer School, SQMS, IL — *participant*

TECHNICAL SKILLS

- **General research:** programming, numerical simulations, data analysis, formal presentations
- **Fields:** quantum information theory, quantum metrology, quantum optics, nuclear physics, quantum nonequilibrium and chaos theory
- **Software:** Python, Cirq, Qiskit, C++, Geant4 Monte Carlo, Mathematica, FRED Photon Engineering, Linux, LaTex
- **Theoretical:** squeezed states, sub-SQL measurements, input-output theory, SYK, JT gravity, holographic bulk reconstruction, thermal correlators, random matrix theory
- **Experimental:** superconducting qubits, optomechanical quantum sensors, Radio-Frequency (RF) measurements, cryogenics, qubit spectroscopy, CCD and CMOS calorimeters