Benjamin Knepper

Berkeley, CA

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EDUCATION

University of California, Berkeley, College of Letters & Science — Berkeley, CA
Majors: Physics (with honors), 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 - present

- Calculating the "standard quantum limit" of measuring the length of a Jackiw-Teitelboim gravity wormhole in the Hartle-Hawking state, using the gravitational path integral and input-output linear response theory
- Identified the Sachdev-Ye-Kitaev dual operator of wormhole length via chord diagrams and Krylov complexity in the triple-scaled limit, and verified it recovers the Schwinger-Dyson conformal propagator
- Devising both digital (qubit) and analog (cold atom cavity) experimental implementations

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

- Developing a protocol to measure an effective "Page curve" in chaotic many-body quantum systems, relating out-of-time-order correlators (OTOCs) to Renyi entropy and quantum Fisher information
- Wrote a successful research proposal to simulate this measurement on AQT superconducting qutrits, with quantum information scrambling generated by pseudorandom unitaries
- Coding OTOC simulations in Google Cirq software for an experimental test underway in winter 2026

Lawrence Berkeley National Laboratory — Berkeley, CA
QuIPS (Quantum Invisible Particle Sensor) Experiment Researcher — 12/2023 - present

- 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 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 - 08/2023

- 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 in InfraBREAD
- Designed an optical configuration involving a Winston Cone and parabolic reflectors that improves quantum

sensing efficiency by 55%, even with misalignments from cryogenic cooling and dark matter halo velocity

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

In Progress:
1. B. Knepper, M. Karydas, D. Carney, J. Sonner. "Quantum Measurement Theory for Holographic Wormhole Length." *To Appear* (early 2026).

Peer Reviewed:
2. G. Hoshino et al. (GigaBREAD Collaboration), *Phys.Rev.Lett.* 134 171002 (2025).
3. M. Tala Pinto et al., *Astronomy & Astrophysics* 694 A268 (2025).
4. S. Knirck et al. (BREAD Collaboration), *Phys.Rev.Lett.* 132 131004 (2024), *Editor's Suggestion.*

Manuscripts:
5. B. Knepper, A. Sonnenschein, S. Knirck, *OSTI* 2377355 (2024).

CONFERENCES & WORKSHOPS

- 2025 & 2023 Superconducting Quantum Materials and Systems (SQMS) Center Conference, IL, — *poster presentations*
- 2025 "Quantum Sensing and Precision Science Summer School" at Johns Hopkins, MD — *participant*
- 2025 & 2024 BASICS (Bay Area Strings, Information & Cosmology Symposium), CA — *participant*
- 2025 APS Global Summit March-April Meeting, Anaheim, CA — *talk*
- 2025 "Observables in Quantum Gravity: From Theory to Experiment" Aspen Center for Physics Conference, CO — *poster presentation*
- 2024 Vienna Quantum Foundations Conference at Institute for Quantum Optics and Quantum Information (IQOQI), Vienna, Austria — *poster presentation*
- 2023 "US Quantum Information Science Summer School" at Fermilab SQMS Center, IL — *participant*

HONORS & AWARDS

- Recipient of the national 2024 American Institute of Physics, Society of Physics Students "Outstanding Undergraduate Research Award", ($2000 research travel, $500 honorarium)

RELEVANT COURSES

- **Graduate courses:** quantum field theory, general relativity, quantum mechanics I and II
- **Electives:** quantum computing and information science, quantum and nonlinear optics
- **Mathematics:** abstract algebra, abstract linear algebra, complex analysis, differential equations

TECHNICAL SKILLS

- **General research:** programming, numerical simulations, data analysis, formal presentations
- **Fields:** quantum information theory, quantum metrology, quantum optics, nuclear physics, 2D holographic quantum gravity
- **Software:** Python, C++, Mathematica, Cirq, Qiskit, Geant4 Monte Carlo, GitHub, FRED Photon Engineering, Linux, Tex
- **Theoretical:** squeezed states, sub-SQL measurements, input-output theory, SYK model, JT gravity, holographic bulk reconstruction, thermal correlators, chord diagrams
- **Experimental:** superconducting qubits, beyond standard model searches, optomechanical quantum sensors, Radio-Frequency (RF) measurements, cryogenics, CCD and CMOS calorimeters