Gurpreet (Gup) Singh

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Education

University of California, Berkeley **December 2022**
Bachelor of Arts, Physics

Experience

Research Data Analyst I / Postgraduate Researcher, *UC Berkeley* **Feb 2026-Aug 2026; Feb 2023-Aug 2024**

- Adapted microcanonical Langevin Monte Carlo (MCLMC) to CUORE/CUPID likelihoods and benchmarked it against BAT.jl Metropolis-Hastings and HMC, characterizing ESS/s scaling from 1 to 28 datasets
- Developed an exact block-gradient method (~O(N²) to ~O(N) cost) that gave the collaboration's MCLMC sampler the best scaling of all samplers tested; the full fit ran in 9 min vs. 87 min with BAT.jl HMC
- Built an HMC sampler from scratch to study and benchmark BAT.jl's mass matrix tuning
- Evaluated an AMD RFSoC 4x2 as MOLLER's real-time data acquisition system (AMD Open Hardware competition): digital down conversion, intermodulation, and noise analysis; ~10.6 effective bits on the 14-bit ADC

Founder & Technical Lead, *Stealth Hardware Startup* **May 2026-Present**

- Set the technical vision and built the first RF hardware/firmware prototype
- Developed the real-time AR sensor-fusion estimator (multi-start Levenberg–Marquardt with uncertainty estimates), cutting time to first position fix 3.5× in replay; now adding an ML inference layer

Researcher, Leinweber Institute for Theoretical Physics **May 2023-Present**

- Built a Bayesian framework to infer the supersymmetry-breaking scale in CMSSM, GSUGRA, and AMSB, combining an adapted FlexibleSUSY RG solver with experimental data and existing limits
- Developed symbolic computational methods to analyze symmetry breaking in chiral gauge theories, later adopted by other graduate students; the work led to two *Physical Review D* papers

DOE SULI Internship, *Lawrence Berkeley National Laboratory* **Aug 2023-May 2024**

- Processed 100M+ QCD simulated events using NERSC supercomputing GPU clusters, training classifiers with custom loss functions on large-scale datasets for particle physics anomaly detection
- Implemented and benchmarked PAWS, a weakly supervised anomaly detection method that incorporates physical priors, improving sensitivity by 10× on the reported benchmark; the work resulted in a *Physical Review Letters* publication and an invited ML4Jets talk at Caltech

Research Assistant, ATLAS Group, UC Berkeley **Jan 2023-Jun 2023**

- Built a data processing pipeline and trained neural network classifiers to identify charm-tagged Λ baryons where traditional methods had failed, using Dalitz informed invariant-mass features from millions of simulated events

Publications

Incorporating Physical Priors into Weakly Supervised Anomaly Detection – **Physical Review Letters** (ML/statistics) **2025**
Generator Based Inference – Preprint, under review at **Data Science in Science** (ML/statistics) **2026**
Exact Results in Softly Broken Supersymmetric Chiral Gauge Theories with Flavor – **Physical Review D** (Theoretical Physics) **2025**
Dynamics of E_6 Chiral Gauge Theories – **Physical Review D** (Theoretical Physics) **2025**

Presentations

ML4Jets, ***California Institute of Technology, Pasadena, CA*** **Aug 2025**
Invited talk on our weakly supervised machine learning method for anomaly detection in particle physics

Skills

Methods: Numerical optimization, Bayesian inference, MCMC (HMC, MCLMC), weakly supervised anomaly detection
Languages: Python (NumPy, SciPy, SymPy, PyTorch, TensorFlow), Java, C++/C, SQL, Julia, LaTeX, React, MATLAB
Compute & Tooling: NERSC GPU clusters, SLURM job orchestration, Git, LabVIEW
Hardware: Electrical Circuits, RF Signal Processing, Soldering, G-code, FPGA/embedded systems

Honors & Awards

Berkeley Transfer Scholarship | The Colorado Space Grant Consortium | Osher Scholarship | Phi Theta Kappa Honors Society