Saumitra Phatak, Ph.D. Candidate

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Personal website Research group website Google Scholar

Profile-Summary

- Ph.D. candidate in Physics with extensive hands-on experience in trapped ultracold-atoms, laser cooling, and dual species experiment. Proven track record in designing and executing neutral-atom tweezer arrays, developing simulation frameworks in Python, and analyzing these quantum systems with a combination of theoretical and experimental approaches. Strong interdisciplinary exposure to optics, control systems, and Li-Cs tweezer platforms with a deep interest in system-level quantum computing development.

Education

2021 – 2026(summer expected) **Ph.D. in Physics,** Purdue University.
CGPA: 3.85/4.00
Thesis: *Novel Imaging and Cooling Techniques with Ultracold Li and Cs Atoms in Optical Tweezers*.
Advisor: Dr. Jonathan Hood.

2017 – 2019 **M.Sc. in Physics,** Mumbai University.
CGPA: 9.25/10.00 *(Silver Medalist)*.

2014 – 2017 **B.Sc. in Physics,** Ramnarain Ruia College.
CGPA: 6.86/7.00 *(Gold Medalist)*.

Professional Experience

2025 **Quantum Innovations Intern, QuEra Computing (R&D).** Working with the neutral-atom quantum computing R&D team on integrating optical innovation, control-system development, and architecture-relevant laser-testing for next-generation quantum hardware.

2021 – Present **Graduate Researcher, HoodLab, Purdue University.** Developed experimental pipelines for trapping single ^{6}Li and ^{133}Cs atoms using optical tweezers; built novel imaging and cooling infrastructure (narrow-line quadrupole transitions, vortex beams, SLM); performed Python simulations of steady-state population dynamics; integrated experimental control with fluorescence data analysis.

2019 – 2021 **Junior Research Fellow, Tata Institute of Fundamental Research (TIFR).** Conducted electron spectroscopy in molecular collisions and simulated ion trajectories in a reaction-microscope; analyzed experimental data using ROOT as part of M.Sc. thesis on Reaction Microscope design.

2021 – 2022 **Teaching Assistant, Department of Physics, Purdue University.** Led weekly undergraduate labs and mentored students in Modern Physics and Classical Mechanics courses; held office hours and ran problem-solving sessions.

2023 **Instructor, AMO-1 Summer Course (online), Department of Physics, Mumbai University.** Delivered lectures on weekends and supervised Masters students on atomic, molecular, and optical physics.

Professional Experience (continued)

2024 **Visiting-Student Mentor, HoodLab, Purdue University.** Supervised University of Chicago summer interns over a 6-week hands-on project in PID loop tuning and optical alignment for neutral-atom trapping.

Skills

Programming — Python (NumPy, SciPy, QuTiP, scikit-learn), Mathematica, ROOT. Four years of experience running dual-species Li–Cs experiments with a Python control system integrated via ArtIQ. Employ machine-learning techniques (scikit-learn, Gaussian process regression) for real-time optimization and high-quality data production.

Tools & Libraries — ArtIQ-FPGA and embedded systems, Git, Origin, LabVIEW. Proficient with Overleaf and Adobe Illustrator for figure preparation. Design and implement PID controllers for laser-power stabilization, safety interlocks, and environmental (temperature/humidity) monitoring.

AMO- engineering — Optical tweezers, vacuum systems, diode lasers, AOMs, EMCCD cameras, Li–Cs spectroscopy, beam shaping (SLM, vortex waveplates). Characterized noise of a 100 W, 1064 nm laser and developed a ramping algorithm to minimize atom heating. Zeroed magnetic fields using Cs magnetometry, performed saturated-absorption/PDH locking, and aligned high-NA objectives. Designed and tested a Li microwave antenna for hyperfine-state driving (network-analyzer analysis) and worked on building a home-made TA laser from a packaged TA chip.

AMO-specific skills — Neutral-atom trapping with enhanced dual-species loading. Model and implement gray-molasses, polarization-gradient, and sideband cooling in optical tweezers. Experience in coherent quantum control, Feshbach spectroscopy, background-free imaging, and single-photon counting (TC-SPCM).

Publications

1. K. N. Blodgett, **Phatak, Saumitra S.**, M. R. Chen, D. Peana, C. Pritts, and J. D. Hood, "Narrow-line electric quadrupole cooling and background-free imaging of a single cs atom with spatially structured light", ***arXiv***, 2025, submitted to **PRX**. eprint: 2505.10540 (physics.atom-ph). [Online]. Available: https://arxiv.org/abs/2505.10540,
Demonstrated the first narrow-line quadrupole cooling of Cs using structured vortex beams, achieving background-free single-atom imaging. Opens new cooling routes on forbidden transitions for scalable tweezer arrays.

2. **Phatak, Saumitra S.**, K. N. Blodgett, D. Peana, M. R. Chen, and J. D. Hood, "Generalized theory for optical cooling of a trapped atom with spin", ***Phys. Rev. A***, vol. 110, no. 4, p. 043 116, Oct. 2024. DOI: 10.1103/PhysRevA.110.043116,
This work presented the first unified theoretical framework that quantitatively merges gray-molasses, Raman-sideband, and polarization-gradient cooling in deep tweezer traps, revealing how spin structure and trap confinement jointly set cooling limits. Is now the go-to reference for trapped single-atom quantum-simulations.

3. K. N. Blodgett, D. Peana, **Phatak, Saumitra S.**, L. M. Terry, M. P. Montes, and J. D. Hood, "Imaging a ^{6}Li atom in an optical tweezer 2000 times with Λ-enhanced gray molasses", ***Phys. Rev. Lett.***, vol. 131, no. 8, p. 083 001, Aug. 2023. DOI: 10.1103/PhysRevLett.131.083001,
Set a new benchmark for high-fidelity detection of light atoms in tweezers over 2000 imaging cycles with greater than 0.9997 fidelity thereby enabling robust neutral-atom quantum simulators based on low-mass species. Our group was the first to demonstrate loading of Lithium in a tweezer from a MOT.

Presentations

Talks

2024 **Theory of cooling and imaging an atom in an optical tweezer.** APS DAMOP 2024, Session G08: Laser Cooling and Trapping II (Fort Worth, TX). Abstract G08.00006; Presenter: Saumitra S. Phatak (Purdue University).

2025 **Imaging and Cooling a single Cs atom trapped in an optical tweezer with a narrow $6S_{1/2}$–$5D_{5/2}$ quadrupole transition.** APS DAMOP 2025, Session C04: Laser Cooling and Trapping I (Portland, OR). Presenter: Saumitra S. Phatak; Authors: K. Blodgett, R. Chen, J. Hood.

Posters

2021 & 2022 Presented posters at the Midwest Cold Atom Workshop (MCAW), covering topics in neutral-atom trapping and laser cooling.

2022 **Progress towards magneto-association of ultracold LiCs molecules in optical tweezers.** APS DAMOP 2022 Poster Session.

2023 **High-Fidelity Imaging of Single ^{6}Li Atom.** APS DAMOP 2023 Poster Session.

Awards and Achievements

2025 **Bilsland Dissertation Fellowship**, Purdue University. Awarded by the Dean of the Graduate School to outstanding PhD candidates in their final year, providing a stipend and full tuition coverage.

Extracurricular Activities

In my spare time I keep a travel-and-research blog and publish along with original poetry, in three different languages, on my personal website/instagram. I'm also a self-taught chess enthusiast with a 2000 rating on Chess.com, a former regional kho-kho athlete with seven years of academy training, and I still regularly play soccer and cricket on weekends.