Samuel Degen

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Education

University of California Los Angeles (UCLA) *9 / 2023 - present*

B.S. Physics

GPA: 3.984 (overall); 4.0 (major)

University of Colorado Boulder *2021 - 2023*

High School Concurrent Enrollment

GPA: 4.0 (overall)

Honors

UCLA Undergraduate Research Scholars Program (URSP) *2025 - 2026*

Undergraduate Research Center - Sciences, UCLA; Los Angeles, CA, USA

- Research scholarship supporting the proposal "Effects of Black Hole Environments on Gravitational Wave Signals: A Field-Theoretic Approach" with Mikhail Solon
- From offer letter: "This selection places you in a distinguished group of undergraduate researchers and represents the College's confidence in your strong academic record and ability to engage in significant research endeavors."

Mani L. Bhaumik Institute for Theoretical Physics Summer Research Fellowship *8 - 9 / 2025*

Mani L. Bhaumik Institute for Theoretical Physics, UCLA; Los Angeles, CA, USA

Advisors: Zvi Bern & Mikhail Solon (Scattering Amplitudes)

- First undergraduate offered a summer research fellowship at UCLA's Bhaumik Institute for Theoretical Physics

University of Tokyo Research Internship Program (UTRIP) *6 - 7 / 2025*

Dept. of Physics, The University of Tokyo (東京大学); Tokyo, Japan

Advisor: Haozhao Liang (Nuclear Theory)

- 1 of 14 students selected from 1,149 applicants for in-person, fully funded 6-week research and culture program in Tokyo
- *Friends of UTokyo, Inc. (FUTI) Global Leadership Award* – prestigious funding award for USA students to research in Japan (1 of 2 UTRIP students)

Perimeter Institute's PSI START Satellite Program *5 / 2025*

(Perimeter Scholars International Students' Training Accelerator for Research in Theory)

Bishop's University; Sherbrooke, Quebec, Canada

- 1 of 3 international students selected for in-person, fully funded 2-week intensive theoretical physics coursework in Quebec, Canada

UCLA Summer Undergraduate Research Fellowship *Summer 2024*

Dept. of Physics & Astronomy, UCLA; Los Angeles, CA, USA

Advisor: E. Paulo Alves (Plasma Theory)

- 1 of 2 first-year undergraduates selected for competitive paid 10-week research fellowship

Member of Colorado Math Team (ARML) *Summer 2023*

2nd in State of Colorado for Core Value Debate *2021*

Presenting and Talks

△ = **invited**

Research

"Effects of Black Hole Environments on Gravitational Wave Signals: A Field-Theoretic Approach"

- California Amplitudes Meeting 2025 (LA), UCLA *[planned 11 / 2025]*

"Physics Without Borders: Nuclear Theory and Global Perspectives from a Summer in Tokyo"

- △ Special Seminar, Physics Summer Research Experience for Undergraduates (REU), UCLA *August 15, 2025*

"Towards a Nonperturbative Many-Body Nuclear Theory: Benchmarking FRG-DFT with the One-Dimensional Fermi Gas"

- UTRIP Final Presentation, The University of Tokyo *August 5, 2025*
- Nuclear Physics Oral Contributions (L04.00005), APS Far West Section Meeting, UC Santa Cruz *[planned October 11, 2025]*

"Data-driven statistical model of nonthermal particle acceleration by the kink instability in relativistic jets"

- Department of Physics Summer Research Talks, UCLA *August 22, 2024*
- Plasma Astrophysics Oral Contributions (NO05.00014), 66th Annual Meeting of the APS Division of Plasma Physics; Atlanta, Georgia *October 9, 2024*

Pedagogy

"From Finite Groups to Lie Algebras: Symmetries and Representations in Physics"

- Perimeter Institute's PSI START Satellite Program, Bishop's University; Quebec, Canada *May 29, 2025*

"Convex Compactness and its Applications"

- APPM 6560 Final Presentation, CU Boulder *May 1, 2023*

Pedagogical Articles

Unpublished

S. Degen, "An Introduction to 3D Gravity from TQFTs" *6 / 2025*
(UCLA PHYS 242C Final Project)

S. Degen, "Tensor Products of Representations of Lie groups" *10 / 2024*
(UCLA MATH 229A Final Project)

Meetings Attended

California Amplitudes Meeting 2025 (LA); Mani L. Bhaumik Institute for Theoretical Physics, UCLA *[planned 11 / 2025]*

2025 Annual Meeting of the APS Far West Section; UC Santa Cruz — *10 / 2025*

2025 Southern California Strings; Mani L. Bhaumik Institute for Theoretical Physics, UCLA — *10 / 2025*

California Amplitudes Meeting 2025 (Davis); Center for Quantum Mathematics and Physics (QMAP), UC Davis — *5 / 2025*

66th Annual Meeting of the APS Division of Plasma Physics; Atlanta, Georgia — *10 / 2024*

Research

The University of Tokyo (東京大学) Undergraduate Researcher — *5/2025 - present*

H. Liang Nuclear Theory Group — *5/2025 - present*

How humans can make a safe and efficient use of nuclei – such as through fission and fusion processes – is a difficult question, requiring a deep microscopic understanding of quantum many-body theories. The treatment of long-lived fission products by nuclear power plants depends strongly on the specifics of quantum many-body tunneling, a long-standing problem that requires a first principles (*ab initio*) theory of properties of nuclei. While there are many established microscopic nuclear theories, the only approach applicable to almost the whole nuclear chart is Density Functional Theory (DFT). Our work uses modern theoretical tools such as Effective Field Theory (EFT) and Renormalization Group (RG) Flow to construct such an *ab initio* nuclear DFT.

Supported by UTRIP 2025 and FUTI Global Leadership Award.

UCLA Undergraduate Researcher — *1/2024 - present*

Z. Bern & M. Solon Scattering Amplitudes Group — *8/2025 - present*

This project develops a new field-theoretic framework to understand how black holes interact with their surrounding environment, such as gas or dark matter, and how these interactions leave imprints on gravitational wave signals. Inspired by methods from gravitational self-force and tidal effective field theory, it aims to model the drag forces experienced by black holes as they move through a medium and predict how these effects could be detected with next-generation observatories. This approach is exciting because it could offer new ways to probe dark matter experimentally or shed new light on the process of jet quenching in QCD, potentially linking similar gravitational, particle, and astrophysical phenomena through a common theoretical language.

Supported by Mani L. Bhaumik Institute for Theoretical Physics Summer 2025 Research Fellowship and 2025 - 2026 UCLA URSP.

E.P. Alves Plasma Theory Group — *4/2024 - 1/2025*

Developed novel ML-based methods for studying time-dependent particle acceleration in relativistic astrophysical jets. My work resolves longstanding limitations of standard models by combining analytic theory and machine learning to uniquely solve ill-posed problems for the first time. Demonstrated that simple energy-dependent models are insufficient to explain the observed nonthermal particle spectrum and that these novel ML methods can be generalized to solve a large class of ill-posed problems—uniquely identifying physical solutions from an infinite family of solutions that perfectly reconstruct the data. Presented results at an international plasma physics conference, where my contributed oral talk initiated discussions toward new collaborations and research directions.

Supported by UCLA Physics Summer 2024 Research Fellowship.

B.C. Regan Condensed Matter Group *1/2024 - 3/2024*

Pedagogical contributions in proving the Feynman Checkerboard at a level suitable for undergraduates, illuminating an accessible way to teach propagators.

Relevant Coursework

UCLA	Graduate	PHYS 215A	Statistical Physics
* *Fall 2025*		PHYS 221A	Quantum Mechanics
† *final papers linked above*		PHYS 221B	Quantum Mechanics
		PHYS 226B	Particle Physics (Standard Model)
		PHYS 226C	Particle Physics (QCD and Higgs)
		PHYS 226D*	Beyond the Standard Model
		PHYS 230A	Quantum Field Theory
		PHYS 230B	Quantum Field Theory
		PHYS 230C	Quantum Field Theory
		PHYS 231B	Mathematical Physics (Lie Theory)
		PHYS 242C†	Topological Quantum Field Theory
		PHYS 291	String Theory Journal Club
		PHYS 495	Teaching College Physics
		MATH 229A†	Lie Groups and Lie Algebras
	Undergrad	PHYS 140A	Solid State
		PHYS 199*	Directed Research
		CSCI 174A	Computer Graphics (JavaScript)
		JAPAN 1-3	Elementary Modern Japanese
		CHIN 1*	Elementary Modern Chinese
CU Boulder	Graduate	PHYS 5770	Gravitational Theory
		APPM 6560	Measure-Theoretic Probability
	Undergrad	CSCI 3104	Algorithms (C++)
		CSCI 4622	Machine Learning (Python)

Service & Outreach

Interviews & Press

FUTI Global Leadership Award (announcement TBA) (report TBA) *8 / 2025*

University of Tokyo Research Internship Program (announcement TBA, archive exp. 12/25) *6 / 2025*

Perimeter Institute's PSI START Satellite (announcement) (interview) *5 / 2025*

Professional Events Chair, Society of Physics Students, UCLA *5 / 2025 - present*

- Organized quarterly talks by faculty, graduate students, and undergraduate student Gong Shows

- Developed extensive resources for summer research opportunities and course planning

Journal Clubs

Amplitudes Journal Club, UCLA Department of Physics *1 / 2025 - present*

- First undergraduate member of this journal club

String Theory Journal Club, UCLA Department of Physics *1 / 2025 - present*

- First undergraduate member of this journal club

Plasma Theory Journal Club, UCLA Department of Physics *4 / 2024 - 1 / 2025*

- Multiple presentations and analyses of recent high-impact papers to theoretical plasma PhD students and faculty
- Discussed theory and application of novel analytic and machine learning methods presented in the club to current projects in the UCLA Plasma Theory group
- First undergraduate to present in this journal club