

ACADEMIC APPOINTMENTS

Harvard Center of Mathematical Sciences and Applications 2021–
Postdoctoral Fellow
Mentors: Profs. David Nelson and L. Mahadevan

EDUCATION

University of California, Santa Barbara 2015–2021
Ph.D. in Physics
Advisor: Prof. Boris Shraiman

Harvard College 2011–2015
A.B. with Honors in Physics and Math

EXPERIENCE

Bowick/Marchetti/Shraiman Groups, University of California, Santa Barbara 2019–2021
Have studied the dynamics of 2D active nematics using tools from statistical physics, complex analysis, and geometry.

Shraiman/Streichan Groups, University of California, Santa Barbara 2017–2021
Studied morphogenesis in the context of *Drosophila*, where I focused on studying the dynamics of myosin. I combined modeling with data analysis to study the importance of myosin and gene expression patterns during morphogenesis.

Kenke Xu Group, University of California, Santa Barbara 2015–2017
Studied and classified a class of topological insulators whose topological nature is characterized by the Hopf map and its generalizations.

Eugene Demler Group, Harvard University Summer/Fall 2014
Proposed and analyzed periodically driven quantum lattice system. Found existence of topologically robust edge states.

LIGO SURF Fellow, Caltech Summer 2014
Modeled a black hole neutron star binary and analyzed the electromagnetic field distribution caused by the precession of neutron star's magnetic dipole. Advised by Prof. Yanbei Chen.

Lene Hau Lab, Harvard University Summer 2013
Analyzed and classified exactly solvable quantum mechanical system of spin interacting with cylindrically symmetric magnetic fields using supersymmetry.

PUBLICATIONS

- [1] B. Lian, C. Vafa, **F. Vafa**, and S.-C. Zhang, “Chern-simons theory and wilson loops in the brillouin zone”, *Phys. Rev. B*, vol. 95, p. 094512, 9 Mar. 2017.
- [2] C. Liu*, **F. Vafa***, and C. Xu, “Symmetry-protected topological hopf insulator and its generalizations”, *Phys. Rev. B*, vol. 95, p. 161116, 16 Apr. 2017.
- [3] **F. Vafa**, M. J. Bowick, M. C. Marchetti, and B. I. Shraiman, “Multi-defect dynamics in active nematics”, 2020. arXiv: [2007.02947](https://arxiv.org/abs/2007.02947) [[cond-mat.soft](#)].
- [4] **F. Vafa**, M. J. Bowick, B. I. Shraiman, and M. C. Marchetti, “Fluctuations can induce local nematic order and extensile stress in monolayers of motile cells”, *Soft Matter*, vol. 17, pp. 3068–3073, 11 2021.
- [5] **F. Vafa**, “Geometry and dynamics of active topological defects”, Available at <https://escholarship.org/uc/item/9v38m6jm>, PhD thesis, University of California, Santa Barbara, Jun. 2021.
- [6] **F. Vafa**, G. H. Zhang, and D. R. Nelson, “Defect absorption and emission for p -atic liquid crystals on cones”, *Phys. Rev. E*, vol. 106, p. 024704, 2 Aug. 2022.
- [7] **F. Vafa** and L. Mahadevan, “Active nematic defects and epithelial morphogenesis”, *Phys. Rev. Lett.*, vol. 129, p. 098102, 9 Aug. 2022.
- [8] **F. Vafa**, “Defect dynamics in active polar fluids vs. active nematics”, *Soft Matter*, vol. 18, no. 42, pp. 8087–8097, 2022.
- [9] **F. Vafa**, D. R. Nelson, and A. Doostmohammadi, “Active topological defect absorption by a curvature singularity”, *Journal of Physics: Condensed Matter*, vol. 35, no. 42, p. 425101, Jul. 2023.
- [10] **F. Vafa** and L. Mahadevan, “Statics and diffusive dynamics of surfaces driven by p -atic topological defects”, *Soft Matter*, vol. 19, pp. 6652–6663, 35 2023.
- [11] **F. Vafa**, D. R. Nelson, and A. Doostmohammadi, “Periodic orbits, pair nucleation, and unbinding of active nematic defects on cones”, 2023. arXiv: [2310.06022](https://arxiv.org/abs/2310.06022) [[cond-mat.soft](#)].

* equal contribution

TALKS

“Liquid crystals, topological defects, and morphogenesis”, Statistical Physics Living Seminar, Isaac Newton Institute, Cambridge, United Kingdom, August 2023

“Dynamics of active nematic defects on cones”, Crossing the Disciplinary Boundaries of Physics (Bohr-100 Centennial Celebrations), Copenhagen, Denmark, August 2023

“Dynamics of active nematic defects on cones”, Quantitative Life Sciences seminar, ICTP, Trieste, Italy, June 2023

“Liquid crystals, topological defects, and morphogenesis”, LMP Seminar, Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany, June 2023

“Liquid crystals, topological defects, and morphogenesis”, MPI-PKS Seminar, Max Planck Institute for the Physics of Complex Systems, Dresden, Germany, May 2023

“Dynamics of active nematic defects on cones”, Physical Mathematics Seminar, MIT, Cambridge, MA, USA, April 2023

“Dynamics of active nematic defects on cones”, APS March meeting, Las Vegas, NV, USA, March 2023

“Dynamics of active nematic defects on cones”, CMSA Member Seminar, Harvard, Cambridge MA, USA, February 2023

“Defect absorption and emission for liquid crystals on cones”, Squishy Physics seminar, Harvard, Cambridge MA, USA, November 2022

“Diffusive growth sourced by topological defects”, Current and Future Themes in Soft and Biological Active Matter, Nordita, Stockholm, Sweden, August 2022

“Diffusive growth sourced by topological defects”, Quantitative Life Sciences seminar, ICTP, Trieste, Italy, July 2022

“ p -atics and Complex Geometry”, NBI Journal Club, Niels Bohr Institute, Copenhagen, Denmark, July 2022

“Diffusive growth sourced by topological defects”, Active & Intelligent Living Matter Conference, Ettore Majorana Foundation and Centre for Scientific Culture, Erice, Sicily, Italy, June 2022

“Diffusive growth sourced by topological defects”, Physics of Living Systems Short Talks, MIT, Cambridge, MA, USA, April 2022

“Diffusive growth sourced by topological defects”, CMSA Member Seminar, Harvard, Cambridge MA, USA, April 2022

“Active nematic defects and epithelial morphogenesis”, APS March meeting, Chicago, IL, USA, March 2022

“Active nematic defects and morphogenesis”, CMSA Member Seminar, Harvard, Cambridge, MA, USA, May 2021

“Fluctuations can induce local nematic order and extensile stress in motile cell monolayers”, APS March meeting, Online, March 2021

“Defect Dynamics in Active Nematics and Polar Fluids”, Physical Mathematics Seminar, MIT, Cambridge, MA, USA, October 2020

“Defect Dynamics in 2D Active Nematics and Polar Fluids”, LMP Seminar, Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany, October 2020

“Dynamics of multi-defect states in active nematics”, KITP Program: Symmetry, Thermodynamics and Topology in Active Matter, Santa Barbara, CA, USA, May 2020

“Symmetry Protected Topological Hopf Insulator and its Generalizations”, APS March meeting, New Orleans, LA, USA, March 2017

TEACHING

Course Assistant for Physical Mathematics I (APM 201) at Harvard Fall 2023
Helped Prof. Michael Brenner restructure the course and gave guest lectures on complex analysis.

Course Assistant for Active Matter (Physics 230) at Harvard Spring 2023
Helped Prof. L Mahadevan structure the course, designed problem sets, and gave a guest lecture on optimal control theory in active matter.

Teaching Assistant at University of California, Santa Barbara 2015–2021
Basic Astronomy (ASTRO 1), Basic Physics (PHYS 1 and 2), Physics Labs (PHYS 3L and 5L), General Physics (PHYS 21, 22, and 24), Intermediate Mechanics (PHYS 103 and 104), Electromagnetism (PHYS 110A), Quantum Mechanics (PHYS 115A, 115B, and 115C), Condensed Matter Physics (PHYS 123B)

SERVICE

Co-organizer of biweekly [Harvard CMSA Active Matter Seminar](#) 2021-

Co-organizer of a set of [Harvard CMSA special lectures on machine learning and protein folding](#) Spring 2023

Referee

Journal of Statistical Mechanics, Royal Society Open Science, Journal of Fluid Mechanics, Science Advances, Nature Communications

Non-residential tutor at Mather House, Harvard 2021-

At Mather House, one of the 12 undergraduate houses in Harvard College with 450 students, offer assistance, advice, and mentorship directly to students and support the students' intellectual, social, cultural, and personal growth.

Reviewer 2020

S.-T. Yau High School Science Award