

Colleen Delaney  
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## Current Position

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Assistant Professor, Purdue University 2024-  
Departments of Math (75%) and Physics & Astronomy (25%)

## Research Areas

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fusion categories, topological order, TQFT, quantum computation and complexity, diagrammatic algebra, higher category theory, quantum invariants of knots/links/3-manifolds, Hopf and weak-Hopf algebras, algebraic combinatorics of QFT

## Academic Appointments

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Postdoctoral Researcher, UC Berkeley 2022-2024  
Zorn Postdoctoral Research Fellow, Indiana University 2019-2022  
S. Della Pietra Postdoctoral Fellow in Quantum Symmetries, MSRI Spring 2020

## Education

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PhD, Mathematics, with Certificate in College and University Teaching, UCSB 2019  
MA, Mathematics, UCSB 2016  
BS, Physics, Caltech 2013

## Research Fellowships and Experience

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Simons Collaboration on Global Categorical Symmetries Postdoctoral Fellow 2022-2024  
NSF Mathematical Sciences Postdoctoral Research Fellow 2020-2022  
Microsoft Station Q Graduate Student Fellow 2016-2017, 2018-2019  
Intern in Computational Physics department at HRL Laboratories Summer 2017  
NSF Graduate Research Fellow 2013-2016

## Selected Research Articles

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1. *Rado matroids and a graphical calculus for boundaries of Wilson loop diagrams.* with Susama Agarwala and Karen Yeats. (Submitted). arXiv:2401.05592
2. *An algorithm for Tambara-Yamagami quantum invariants of 3-manifolds, parametrized by the first Betti number.* with Clément Maria and Eric Samperton. (Accepted to **SoCG 2025**.) arXiv:2311.08514
3. *Zesting produces modular isotopes and explains their topological invariants.* with Sung Kim and Julia Plavnik. (Submitted). arXiv:2107.11374

## Selected Research Articles (Continued)

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- 4 *G-crossed braided zesting*. with César Galindo, Julia Plavnik, Eric C. Rowell, and Qing Zhang **Journal of the London Mathematical Society**. Vol. 109. (2024). arXiv:2212.05336
- 5 *Braided zesting and its applications*. with César Galindo, Julia Plavnik, Eric C. Rowell, and Qing Zhang. **Communications in Mathematical Physics**. Vol. 386. (2021). arXiv:2005.05544
- 6 *Symmetry defects and their application to topological quantum computing*. with Zhenghan Wang. **AMS Contemporary Mathematics Series**. Vol. 747. (2020). arXiv:1811.02143
- 7 *On invariants of modular categories beyond modular data*. with Parsa Bonderson, César Galindo, Eric C. Rowell, Alan Tran, Zhenghan Wang. **Journal of Pure and Applied Algebra**. Vol. 223. (2019). arXiv:1805.05736
- 8 *Local unitary representations of the braid group and their application to quantum computing*. with Eric C. Rowell and Zhenghan Wang. **Revista Colombiana de Matemáticas**. Vol. 50 No. 2. (2016). arXiv:1604.06429
- 9 *Dyson-Schwinger equations and the theory of computation*. with Matilde Marcolli. “Feynman Amplitudes, Periods and Motives”, **Clay Math Institute and AMS**. (2015). arXiv:1302.5040
- 10 *Generalizing the Connes-Moscovici Hopf algebra to contain all rooted trees*. with Susama Agarwala. **Journal of Mathematical Physics**, Vol. 56, No. 4, (2015). arXiv: 1302.4004

## Research Mentorship Experience and Achievements

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Indiana University Outstanding Faculty Mentor Award	2021
• Emerging Scholars Program Mentor at Indiana University	2020-2021
• REU Program Mentor at Indiana University	Summer 2020
• Directed Reading Program (DRP) Mentor at UCSB	Spring 2019

## Research Community Co-organizing

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JMM Special Session: MTCs and TQFTs beyond the finite & semisimple with N. Geer	2024
IPAM Workshop on Topology, Quantum Error Correction, and Quantum Gravity with A. Anshu, M. Junge, R. Lutchyn, J. Wright, Z. Wang	2023
BIRS Workshop on Equivariant Bordism Theory and Applications with R. Jimenez, C. Segovia, E. Samperton, B. Uribe	2023

## Research Community Co-organizing (continued)

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Simons Collaboration on Global Categorical Symmetries Postdoc/Student Seminar with T. D. Brennan, L. Müller	2022 - 2023
JMM Special Session: Fusion categories and their Applications in Physics with C. Jones	2022
IU Quantum Topology Seminar with D. Lopez-Neumann	2021-2022
IPAM Graduate Summer School on the Mathematics of Topological Phases of Matter with M. Freedman, M. Hastings, Z. Wang	2021
AWM Research Symposium Session on Braid Groups and Quantum Computing with J. Vasquez and H. Wong	2019
UCSB Quantum Algebra and Topology Seminar	2016-2019

## Service Activities

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- Faculty Advisory Board Member, Purdue Journal of Undergraduate Research 2024-2025
- Mentor for UC Berkeley Mathematical and Physical Sciences Scholars program 2023-2024
  - oversaw 7 undergraduates through the Society of Physics Students (SPS)
- Math Circle at Texas A & M Spring 2018
- Scholarships for Transfer Students to Engage and Excel (STEEM) Mentor 2014-2016

## Teaching Experience

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### Graduate Level

Mini-course on Fusion categories at the Atlantic TQFT school Summer 2023

### Undergraduate Level

at Purdue University:

- Math 366 - Ordinary Differential Equations Fall 2024  
*A first course on the subject for math majors.*

## Teaching Experience (continued)

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at Indiana University:

- Engineering 201 - Linear Algebra for Data Science<sup>1</sup> Online Spring 2021  
*Implementing linear algebra in MATLAB and Python with an emphasis on matrix factorizations and their applications to data analysis*
- Math 118 - Finite Mathematics Fall 2019, Online Fall 2020  
*Elementary set theory, probability, and combinatorics, stochastic processes, solving linear equations, matrix algebra, linear programming, and Markov chains.*

at UC Santa Barbara:

- Math 3B - Calculus with Applications II Summer 2018  
*Riemann sums, area under curves, polynomial and trigonometric substitution, integration by parts, partial fraction decomposition, areas of surfaces of revolution, volumes of solids*

## Invited Talks

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### Colloquium Talks

- The math behind a periodic table for 2d quantum matter* 2022  
St. Mary's College Math Colloquium
- Tensor categories, knots, and 2d quantum matter* 2022
- University of New Hampshire
  - Texas A&M University
  - Utah State University

### In-person Seminar or Conference Talks

- An efficient\* classical algorithm for some quantum 3-manifold invariants* 2024
- Quantum Symmetries Reunion Program @ SLMATH
  - Midwest Topology Seminar
  - AMS Western Sectional Session on Tensor Categories and Noncommutative Algebras
  - Graduate Student Conference in Topology and Geometry (Early Career Speaker)
  - Quantum Topology, Quantum Information, and Connections to Mathematical Physics
- Zesting topological order and symmetry-enriched topological order in (2+1)D* 2024  
Higher Categorical Tools for Quantum Phases of Matter
- On the classification of (2+1)D topological order via modular fusion categories* 2024  
UC Davis Mathematical Physics Seminar
- Zesting anyons and symmetry defects* 2023  
ICMS Workshop on Topological Quantum Computation

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<sup>1</sup>Developed new curriculum.

### In-person Seminar or Conference Talks (continued)

<i>HQFT interpretation of the zesting construction on ribbon categories</i> CAN–MEX–USA 5th Conference in Rep. Theory, Noncomm. Algebra, and Categorification	2023
<i>Tinkering with tensor categories</i> UC Berkeley Tensor categories and representation theory seminar	2022
<i>Hopf algebras play an analogous role in some topological and non-topological QFTs</i> Global Categorical Symmetries Conference at the Perimeter Institute	2022
<i>Knots and modular isotopes</i> Purdue Mathematical Physics Seminar	2021
<i>Zesting produces modular isotopes</i> BIRS-IASM Workshop on Subfactors, Vertex Operator Algebras, and Tensor Categories	2021
<i>Modular Data and Beyond</i> Introduction to Quantum Symmetries Workshop MSRI	2020
<i>Algebraic theory of bilayer symmetry defects</i> Vanderbilt NCGOA: Algebra and Geometry Quantized and Quantified	2019
<i>Fusion categories and quantum computing</i> <ul style="list-style-type: none"><li>• USC Categorification Seminar</li><li>• UCR Applied Category Theory Seminar</li></ul>	2018, 2019
<i>Link invariants and anyon models</i> OSU Quantum algebra and quantum topology seminar, Claremont Topology Seminar	2018
<i>Fusion rules for permutation-extensions of modular categories</i> BIRS Workshop on Subfactors and Quantum Symmetries	2018
<i>Topological quantum computing with symmetry defects</i> AMS Special Session on Topological Phases of Matter and Quantum Computation	2016

### Virtual Talks

<i>An efficient* classical algorithm for some quantum invariants of 3-manifolds</i> Topological Quantum Field Theory Club	2024
<i>Zesting and 3D TQFTs</i> Higher Structures and Field Theory Seminar	2024

## Virtual Talks (continued)

*Zesting and Reshetikhin-Turaev invariants* 2021-2022

- UCSB Quantum Algebra and Topology Seminar
- Leeds Algebra Seminar
- (Cardiff) Mathematical Physics-Physical Mathematics Seminar
- Atlantic Category Theory Seminar
- Seminario de Categorías UNAM
- LSU Mathematical Physics and Representation Theory Seminar
- Remote Rendezvous for Quantum Topologists

*What happens to quantum information under topological phase transitions?* 2021

Perimeter Institute Mathematical Physics Seminar

## Outreach Talks

*Knots and quantum computing* 2024

MAA MathFest Session on “Knot theory and not knot theory”

*The math behind a periodic table for 2d quantum matter*

- Purdue University Math Club 2024
- UC Berkeley Mathematics Undergraduate Student Association “Math Mondays” 2023

*An introduction to topological quantum computing* 2021

IU Math Club

*Modular Isotopes* 2020

Academic Sponsor’s Day at MSRI

*Processing quantum information with pictures* 2018

UCSB AWM Undergraduate Chapter Meeting

## Talks Outside Academia

HRL Laboratories

*Introduction to the mathematics of topological quantum computing* 2017