# GOPIKA MADHU

## CONTACT INFORMATION

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## EDUCATION

- **PhD in Physics** (2022-present)
  Department of Physics,
  University of Miami, FL
  *Advisor:* Professor Vivek N. Prakash
  *CGPA:* 3.85/4

- **BS-MS Dual Degree in Science, Major in Physics** (2016-2021)
  Indian Institute of Science Education and Research - Pune (IISER Pune), India
  *Dissertation Title:* Devising techniques to probe the mechanical response of axons.
  *Advisor:* Dr Pramod A. Pullarkat (RRI, Bangalore, India)

## RESEARCH INTERESTS

Tissue Mechanics, Active Matter, Fracture Mechanics, Collective Cell Dynamics, Cellular Rearrangement, Microscopy Techniques

## PUBLICATIONS

- Gopika Madhu*, Carolyn Delli-Santi*, Jenna Efrein, Prannoy Suraneni, Landolf Rhode-Barbarigos, Vivek N. Prakash. *Glass-based physical models for tissue mechanics*. (**Under Preparation for PLOS ONE**) (2026)
  *Equal Contribution

- Juyeon Hong, Chanjae Lee, Gopika Madhu, Ophelia Papoulas, Ece Atayeter, Gabriel Hoogerbrugge, Jiehong Pan, Maki Takagishi, Nadia I. Manzi, Daniel J. Dickinson, Amjad Horani, Steven L. Brody, Edward M. Marcotte, Vivek N. Prakash, Tae Joo Park, John B. Wallingford. *A protein complex in the extreme distal tip of vertebrate motile cilia controls their organization, length, and function*. ***Nature Communications*** **17**, 394 (2026). https://doi.org/10.1038/s41467-025-67086-9.

- Setareh Gooshvar*, Gopika Madhu*, Melissa Ruszczyk, Vivek N Prakash, *Non-Bilaterians as Model Systems for Tissue Mechanics*, ***Integrative and Comparative Biology***, Volume 63, Issue 6, December 2023, Pages 1442–1454. https://doi.org/10.1093/icb/icad074
  *Equal Contribution

- Gopika Madhu, Molly McCord, Jonah Spencer, Katherine Kafkis, Jacob Notbohm, Vivek N. Prakash, *Quantifying Ciliary-generated Traction Forces during Locomotion in a Simple Marine Animal's Epithelial Tissues*, Advancements in Optical Methods, Digital Image Correlation & Mechanics of Biological Systems and Materials, Volume 2. SEM 2024. **Conference Proceedings of the Society for Experimental Mechanics Series**. Springer, Cham. https://doi.org/10.1007/978-3-031-85833-8_11

## HONORS & AWARDS

- **NSF IPoLS Student Network (2025)**
  Selected to attend Python Bootcamp organized by IPoLS (Physics of Living Systems) Student Network at Emory University.

- **Summer Doctoral Micro-Grant (2025)**
  For research support to doctoral students during the summer by Graduate School, University of Miami.

- **Media Coverage (2024)**

Physics Magazine: "Modeling Tissue Mechanics with Molten Glass"

- **KVPY Scholarship (2016 to 2021)**, All India Rank – 445
  Kishore Vaigyanik Protsahan Yojana (KVPY) is a national fellowship program funded by the Department of Science and Technology, India.

## PRESENTATIONS & WORKSHOPS

- **Biomolecules on the Beach 2026**, Frost Institute for Chemistry & Molecular Science, University of Miami
- **Graduate and Postdoctoral Research Symposium 2026**, University of Miami, Florida
  Poster: "Velocity Correlation Length as a Control Parameter for Emergent Motility in *Trichoplax adhaerens*"
- **Workshop: IPoLS Scientific Programming in Python Bootcamp 2025**, Emory University
- **Evaluator: Research, Creativity, and Innovation Forum (RCIF) 2025**, University of Miami
- **Invertebrate Neuroscience meeting 2025**, University of Miami, Florida
  Oral Talk: "Ductile-Brittle Deformations in Tissue Monolayer"
- **Graduate and Postdoctoral Research Symposium 2025**, University of Miami, Florida
  Oral Talk: "Quantifying Ductile-Brittle Deformations in a Novel Epithelial System"
- **APS March Meeting 2024**, Minneapolis, Minnesota
  Oral Talk: "Glass Art, Physics, and Marine Biology: Outreach using the Glass Shop as a Laboratory for Tissue Biophysics in Marine Animals"

## RESEARCH PROJECTS

### PhD Research

- **Correlation Length as a Unifying Parameter for Tissue-Scale Motion in *Trichoplax adhaerens*.** (2025 - present)
  *Supervisor:* Dr Vivek N. Prakash, Department of Physics, University of Miami
  *Summary:* Quantifying spatial velocity correlations from PIV data to identify the ratio of correlation length to organism size (ξ/L) as a unifying parameter governing transition between translation, rotation, and deformation modes in active epithelial tissues.

- **Quantifying Cilia-Driven Fluid Flow Using Particle Image Velocimetry in Frog Embryo.** (2025)
  *Supervisor:* Dr Vivek N. Prakash (University of Miami), Dr John B. Wallingford (University of Texas, Austin)
  *Summary:* Computed velocity fields from time-lapse microscopy data using particle image velocimetry to quantify cilia-driven fluid flow dynamics. Quantitative flow analysis supported the conclusion that protein complexes at the distal tip of motile cilia regulate cilia organization, length, and coordinated beating necessary for effective fluid transport.

- **Quantifying Ductile-Brittle deformations in a Novel Epithelial System, *Trichoplax adhaerens*.** (2024-2025)
  *Supervisor:* Dr Vivek N. Prakash (University of Miami), Dr Jacob Notbohm (University of Wisconsin-Madison)
  *Summary:* Measured traction forces and internal stress distributions in *Trichoplax adhaerens* using traction force microscopy on polyacrylamide substrates of controlled stiffness.

- **Physical Analog Modeling of Epithelial Tissue Using Glass.** (2023-2024)
  *Supervisor:* Dr Vivek N. Prakash (Department of Physics), Dr Jenna Efrein (Department of Art & Art History), Dr Landolf Rhode-Barbarigos (Department of Civil and Architectural Engineering)
  *Summary:* Developed glass-based physical models of epithelial tissue by fabricating and stretching fused glass "cells" to simulate tissue deformation and validate mechanical response using image-based measurements of area and eccentricity.

### Master's Thesis

- **Devising techniques to probe the mechanical response of axons**. (2021)
  *Place:* Cellular Biophysics Lab, Raman Research Institute, Bangalore, India
  *Thesis Advisory Committee:* Dr Pramod A. Pullarkat (RRI, Bangalore), Dr G. V. Pavan Kumar (IISER Pune)
  *Summary:* Designing, fabricating and characterizing Polydimethylsiloxane (PDMS) based stretcher device to observe the membrane periodic skeleton under stretch deformation using super-resolution imaging.

### Undergraduate Research

- **Nitrogen-Vacancy Centers in Diamonds**. (August- November 2019)

*Supervisor:* Dr T. S. Mahesh, NV Center Lab, IISER Pune, India
*Summary:* Familiarization with NV Centre set up to obtain ODMR signals from NV centers in diamonds.

- Photon Entanglement via Spontaneous Parametric Down Conversion (SPDC). (July 2019)
  *Supervisor:* Dr. Raghavan, Indira Gandhi Centre of Atomic Research, Kalpakkam, India
  *Summary:* Familiarization with the production of entangled photons via SPDC using beta barium borate crystal.

- Surface Enhanced Raman Spectroscopy (SERS) in nanorods. (January – June 2019)
  *Supervisor:* Dr G. V. Pavan Kumar, Plasmonics Lab, IISER Pune, India
  *Summary:* Familiarization with SERS, back focal plane imaging, and literature survey on liquid crystals.

- Determining refractive index of Nanomaterials. (May-June 2018)
  *Supervisor:* Dr C. V. Krishnamurthy, Indian Institute of Technology Madras, India
  *Summary:* TiO2 microspheres were synthesized and characterized, followed by obtaining diffraction pattern images, and compared to various Mei plots of varying refractive indices to obtain an optimal fit for the graphs.

- Synthesis and Characterization of Layered Magnetic Oxides by Hydrothermal Route. (May-June 2017)
  *Supervisor:* Dr Ashna Bajpai, IISER Pune, India
  *Summary:* YFeO3 particles were synthesized by successive hydrothermal processing and high-temperature calcination. This was followed by characterization using X-ray diffraction.

## MENTORSHIP

- Ivan Levkovsky – Summer 2023
  Undergraduate, B.S. Chemistry, University of Miami (class of 2024)

- Emma Nance – Spring 2026
  Undergraduate, B.S. Marine Biology, University of Miami

## TEACHING

(At University of Miami, August 2022 – April 2026)
Laboratory Courses
- PHY106: College Physics Laboratory I - Fall 2022
- PHY108: College Physics Laboratory II - Spring 2024, Fall 2024, Spring 2025, Spring 2026
- PHY224: University Physics Laboratory II - Fall 2022, Spring 2023, Fall 2023

Grading
- Intro to Modern Physics – Fall 2024
- Biological Physics I – Fall 2024
- University Physics – Fall 2025

## GRADUATE COURSEWORK

(At University of Miami, August 2022 – April 2026)
- Biological Physics
- Quantum Physics I
- Classical Mechanics II
- Introduction to Modern Physics
- Introduction to Astrophysics
- Quantum Mechanics II
- Statistical Physics I
- Electromagnetic Theory I
- Quantum Computation
- Electromagnetic Theory II
- Quantum Theory I
- Elementary Particle Physics

## TECHNICAL SKILLS

- Computational Skills: MATLAB, Python, Image J, Mathematica, Origin, LabVIEW (beginner), COMSOL (beginner), Qiskit (beginner) & MESA (beginner).

- Experimental Skills: Particle Image Velocimetry (PIV), Spatial Pairwise correlation, Fluorescence Microscopy, Basic XRD, NV Centre set up, production of entangled photons using BBO crystal, Chick embryo dissection & culturing, Marine organismal cultures.

## OUTREACH

- Summer 2024, 2025
  Helped organize our lab's **Physics/Biology outreach workshops for UM First Star Academy students (K–12)**. First Star Academy supports high school students in foster care pursuing STEM and higher education.

- Early March 2024, 2025, 2026
  **Physics Fun at University of Miami**. An annual outreach event hosted by the Department of Physics, offering live demonstrations, hands-on science experiments and interactive tables.

## REFERENCES


**Dr. Vivek N. Prakash,**
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**Dr. Pramod A. Pullarkat,**
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