ARAVIND RAO KARANAM

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PROFESSIONAL EXPERIENCE

Postdoctoral Research Associate July 2024 – present

School of Physics and Astronomy, Rochester Institute of Technology
Rochester, New York 14623
Research Advisor: Prof. Moumita Das

Graduate Research Assistant October 2017 – June 2024

Department of Physics, University of California, San Diego
La Jolla, California 92093
Research Advisor: Dr. Wouter-Jan Rappel

EDUCATION

Ph.D. in Physics with a specialization in Q-Bio (2024)
University of California, San Diego
Thesis Title: Signaling Pathways in Living Systems
Research Advisor: Dr. Wouter-Jan Rappel

M.S. in Physics (2017)
B.S. in Physics (2016)
Indian Institute of Science, Bangalore
Research Advisor: Prof. Srikanth Sastry, JNCASR, Bangalore

RESEARCH PROJECTS

1. **Computational modeling of network restructuring in active cytoskeletal composites**

   Active Cytoskeletal Composites (ACCs) are composed of actin and microtubule filaments, active motors, and passive crosslinkers. They display novel mechanical properties that can be harnessed to synthesize controllable active materials. We model the dynamics of the composites using large-scale multi-threaded Brownian Dynamics simulations to predict the restructuring of the composite and to inform the formulation of hydrodynamic theories.

2. **Computational and theoretical modeling of the cytoskeleton of *Stentor coeruleus* to understand its wound healing abilities**

   The single-celled ciliate *Stentor coeruleus* can withstand substantial mechanical deformation and can also heal large wounds. Our work studies the response of *Stentor*'s cytoskeleton to large-scale damage, coupled with calcium signaling triggered by the wound formation. This study offers insights into wound-healing mechanisms at the level of individual cells.

3. **Computational modeling contraction of pinned actomyosin gels**

   Actomyosin gels, consisting of f-actin, myosin motors, and other auxiliary proteins, undergo contraction in a variety of contexts in animal cells to generate motion. To study the interactions between the gel and the boundary, we study a two-dimensional model of the gel that is initially pinned at the boundary. We study how the development and propagation of active stresses causes the the actin network to depin and contract globally.

4. **Analysis and modeling of eukaryotic chemotaxis under periodic stimuli**

   An analysis of the chemotaxis of the social amoeba *Dictyostelium*, when exposed to multiple waves of the chemoattractant, showed that the chemotactic ability of the cells improves upon exposure to more waves provided the wave period is small. A model for this frequency-dependent growth in chemotactic ability was developed that was also compatible with earlier studies. The improvement in chemotaxis was shown to involve temporal gradient sensing besides spatial gradient sensing, while earlier models focused solely on the latter.

5. **Boolean modeling of guard cell signaling in leaves, and GUI development for simulating Boolean networks**

   An existing Boolean model of guard cell signaling in leaves, leading to the closure of stomata in response to a plant hormone ABA, was extended to include the effect of CO_2. The extended model, verified by conductance experiments in leaves, shows an additive effect of ABA and CO_2 on stomatal closure. An open-source GUI software to simulate and analyze user-defined Boolean networks was developed and used in this project, and was made available to the community.

6. **Characterizing the yielding transition in athermal elastic materials close to the jamming density**

   Stress, strain, and particle displacements were analyzed by simulating cyclic shearing of a model system for soft materials with densities close to the jamming density. The dependence of the yielding transition on the packing densities was examined.

PUBLICATIONS

ORCID Profile: `https://orcid.org/0000-0003-3883-0619/`

1. Karmakar, R., **Karanam, A.**, Tang, M.H. and Rappel, W.J., 2024. Eukaryotic chemotaxis under periodic stimulation shows temporal gradient dependence. Phys. Rev. Lett. 133, 068401
2. **Karanam, A.** and Rappel, W.J., 2022. Boolean modelling in plant biology. Quantitative Plant Biology, 3, p.e29. (Review Article)
3. **Karanam, A.**, He, D., Hsu, P.K., Schulze, S., Dubeaux, G., Karmakar, R., Schroeder, J.I. and Rappel, W.J., 2021. Boolink: a graphical interface for open access Boolean network simulations and use in guard cell CO_2 signaling. Plant Physiology, 187(4), pp.2311-2322.
4. Karmakar, R., Tang, M.H., Yue, H., Lombardo, D., **Karanam, A.**, Camley, B.A., Groisman, A. and Rappel, W.J., 2021. Cellular memory in eukaryotic chemotaxis depends on the background chemoattractant concentration. Physical Review E, 103(1), p.012402.

TALKS AND WORKSHOPS

1. Restructuring and Mechanics of Active Cytoskeletal Composites: A Coarse-Grained Simulation Study. Poster at the Gordon Research Seminar and Conference on Soft Condensed Matter Physics, New London NH (2025)
2. Hacktive Matter Hackathon, UC Santa Barbara (2025)
3. Modeling cytoskeletal mechanics in wound closure in *Stentor coeruleus*. Contributed talk at the APS Global Physics Summit, Anaheim CA (2025)
4. Riding the cAMP Wave: Maximizing Cell Migration by Slow Chemoattractant Waves. Contributed talk at the APS March Meeting, Chicago, IL. (2022)
5. Improved Chemotaxis by Repeated Stimulation. Contributed talk at the APS March Meeting. (virtual, 2021).
6. Variation of chemotaxis in *Dictyostelium*. Poster at the Annual Q-Bio Symposium, UC San Diego. (2019)
7. Bangalore School of Statistical Physics, ICTS-TIFR, Bangalore, India. (2016)

8. Physics of Life, NCBS-Simons Annual Monsoon School, Bangalore, India. (2015)

TEACHING EXPERIENCE

Guest Lecturer April 2025
Rochester Institute of Technology

· Phys 640 Statistical Mechanics for physics and astronomy graduate students
· Topics covered: Interpretations of entropy, simulations of 1-d and 2-d Ising model, Metropolis algorithm.

Instructor of Record July 2022
UC San Diego

· Instructor to Phys 2C, a calculus-based course on introductory physics covering waves, optics, thermodynamics, and fluid mechanics; designed course materials, exams, and homework; delivered lectures; supervised teaching assistants.
· Class composition and size: Non-physics STEM majors, 60 students.

Teaching Assistant October 2018 - September 2023
UC San Diego

· Led weekly in-class discussions, laboratory sessions, and office hours; graded students' work and provided feedback ; co-ordinated course logistics with other TA's.
· Class topics, composition, and size: Phys 2A/B/C, Phys 1A/B/C-L (a three lecture/lab series on introductory physics for non-physics STEM majors, 60–300 students), Phys 4B (Introduction to waves, fluids, and thermodynamics for physics majors, 60 students), Phys 201 (Graduate level Mathematical Methods, 45 students).

Pedagogy Training 2021–2022
UC San Diego

· Fellow, Summer Graduate Teaching Scholars (SGTS) Program. SGTS is a campus-wide selective program offered by the Teaching and Learning Commons (TLC) at UC San Diego for graduate students interested in teaching. The program offers mentorship by experienced instructors and opportunities to collaborate, network among peers and to reflect on the course while serving as an instructor of record during the summer.
· Took the pedagogy courses offered by TLC, Introduction to College Teaching and Course Design Workshop; trained in the best practices in active learning, in designing teaching and evaluation methods to improve outcomes and to foster diversity, equity, and inclusion (DEI).

MISCELLANEOUS

- Programming languages: C, C++, python, MATLAB, `bash`.
- Technical software: ImageJ, Inkscape, Git, LaTeX.