Praful Gagrani

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Education

University of Wisconsin — Madison, WI
Ph.D. in Physics, Advisors: Eric Smith, David Baum — 2018–2023
- Thesis: Mathematics of evolution in chemical reaction networks and the origins of biochemical life

Kansas State University — Manhattan, KS
M.S. in Physics, Advisor: Lado Samushia — 2016–2018
- Thesis: Improvement in techniques for understanding the large scale structure of the Universe

Indian Institute of Technology — New Delhi
B.Tech. in Engineering Physics — 2011–2015

Interests

I am primarily interested in applying mathematical physics towards building techniques for understanding various aspects of complex systems. My research interests include non-equilibrium statistical mechanics, Hamiltonian dynamical systems, chemical reaction networks, information geometry, symplectic geometry and numerical physics. I am also broadly interested in learning about the conceptual, mathematical, or computational aspects of any phenomena that can be modeled as a complex system. My learning interests include cosmology, condensed matter physics, the origin of life, biochemistry and biology.

Experience

University of Wisconsin-Madison — Madison, WI
Postdoctoral Researcher at the Wisconsin Institute for Discovery, PI: David Baum — Fall 2023 onwards
- Origins of life

Kansas State University — Manhattan, KS
Intern at the Department of Physics, Guide: Lado Samushia — Spring 2016
- Information content of the angular multipoles of galaxy bispectrum

University of Texas-Austin — Austin, TX
Intern at the Department of Astronomy, Guide: Paul Shapiro — Fall 2015
- Supersonic baryon-dark matter drift velocity

University of California — Davis, CA
Intern at the Department of Physics and Astronomy, Guide: Lloyd Knox — Summer 2014
- Gravitational driving of acoustic oscillations in primordial plasma

Publications

Praful Gagrani, Victor Blanco, Eric Smith, David Baum
Polyhedral geometry and combinatorics of an autocatalytic ecology in chemical and cluster chemical reaction networks
Submitted to Journal of Mathematical Chemistry, 2023

Praful Gagrani, Eric Smith
Action functional gradient descent algorithm for estimating escape paths in stochastic chemical reaction networks
Physical Review E, 2023

Zhen Peng, Alex Plum, **Praful Gagrani**, David Baum
An ecological framework for the analysis of prebiotic chemical reaction networks
Journal of theoretical biology, 2020

Praful Gagrani, Lado Samushia
Information content of the angular multipoles of redshift-space galaxy bispectrum
Monthly Notices of the Royal Astronomical Society, 2017

David W. Pearson, Lado Samushia, **Praful Gagrani**
Optimal weights for measuring redshift space distortions in multitracer galaxy catalogues
Monthly Notices of the Royal Astronomical Society, 2016

WORKING PAPERS

Praful Gagrani, Vladimir Sotirov, David A. Baum , Eric Smith
Evolution in chemical reaction networks and the origins of biochemical life
Manuscript, 2023

Talks, Outreach and Teaching

- **Invited speaker** at the University of Wisconsin-Madison   Apr 2023
  Talk on *A(ction) functional gradient descent algorithm for finding instantons in chemical reaction networks*.
- **Invited speaker** at the French National Centre for Scientific Research (CNRS)   Mar 2023
  Zoom talk on *the geometry and combinatorics of an autocatalytic ecology* to Philippe Nghe and collaborators.
- **Invited speaker** at Morgridge Institute for Research   Jun 2021
  Rural summer science camp.
- **Outreach volunteer** at University of Wisconsin-Madison   Oct 2020
  Hands-on physics for fifth graders (news article).
- **Teaching Assistant** at University of Wisconsin-Madison   2018 –2022
  Courses include physics for non-physics, physics, and advanced physics undergraduates.
- **Invited speaker** at University of Portsmouth   Jun 2017
  Talk on *information content of bispectrum* at the Institute of Cosmology and Gravitation (ICG).
- **Teaching Assistant** at Kansas State University   2016 –2017
  Introductory physics for physics majors.

Courses

- **Physics:** Quantum field theory, general relativity, advanced solid state, group theory in physics
- **Mathematics:** Abstract algebra, complex analysis, Lie algebras and representations, differential geometry
- **Biology:** Foundations of evolution, astrobiology seminar

Languages

- **Coding:** MATLAB, Mathematica, Python
- **Spoken:** English, Hindi

Extracurricular Interests

- Eastern, postmodern and Whiteheadean philosophy
  YouTube link to a dialogue with Matt Segall, a Whiteheadean scholar.

- Proficient guitarist
  Stood 3rd in OPUS: Battle of the Bands, 2016 at KSU (YouTube link).

- Automatic music transcription
  Stood 3rd in national level Technical Paper Presentation for the project *Automatic Transcription of Recorded Music for Single Instrument* (Winter 2012) in a paper titled *Decoding Music* at Tryst, technical festival of IIT.