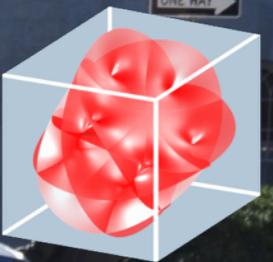


# HARVARD UNIVERSITY CENTER OF MATHEMATICAL SCIENCES AND APPLICATIONS

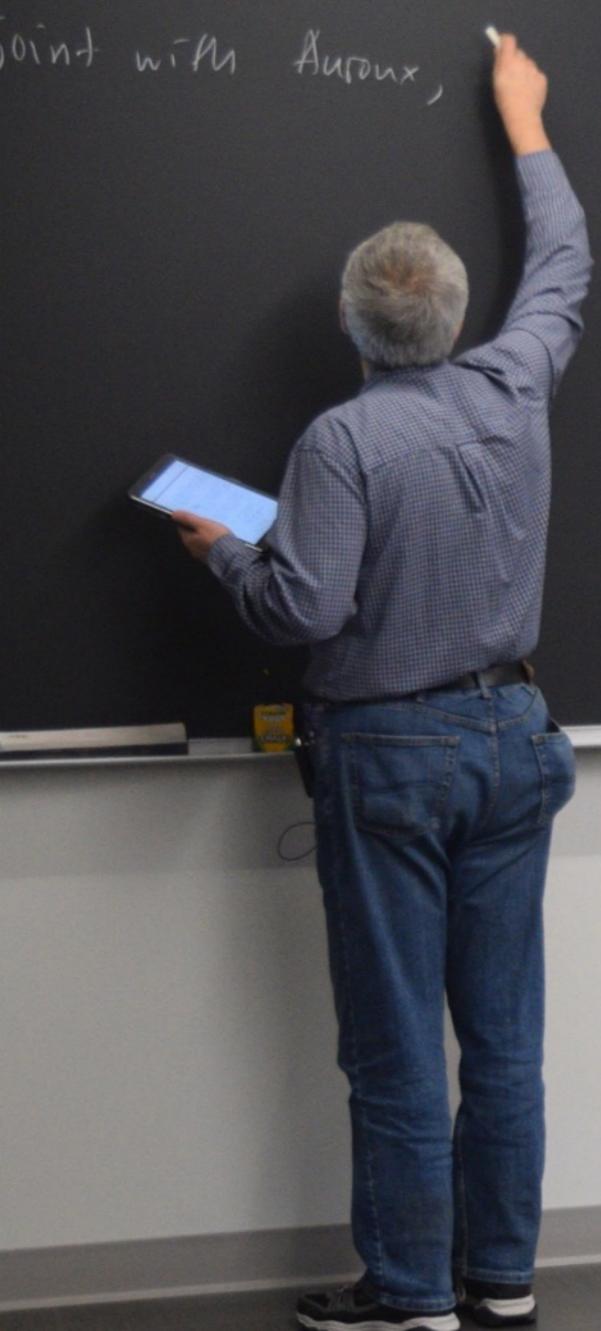


A fusion point of mathematics, statistics, physics, and related sciences



From early discoveries of the laws of geometry to contemporary theories of new materials and the nature of the universe, mathematics has supplied the tools and concepts that underpin millennia of scientific achievements. Even today, the convergence of pure mathematics and applied science lies at the heart of advancements in the fields of computer science, statistics, economics, and physics, as well many other areas of study.

Given mathematics' central and essential relationship to discoveries in so many fields, the Center of Mathematical Sciences strives to push for further integration and more regular and fluid communication between mathematics and a broad range of hard and soft sciences. The CMSA has established strong connections not only between mathematicians and researchers from other science departments at the FAS, but also between schools (Harvard Medical School, Business School, SEAS) and institutions (MIT, Brandeis, Aarhus University.)



The Center of Mathematical Sciences and Applications hosts a field of postdocs, faculty, and special programs explored through various workshops. Seminars on topics ranging from Mirror Symmetry to Social Sciences are held weekly.

By bringing together researchers from an extensive variety of disciplines and institutions, the Center serves as a fusion point for mathematics, statistics, physics, and related sciences.



Salem Al Mosleh  
Postdoctoral fellow

Nishanth Gudapati  
Postdoctoral fellow

Aghil Alaee  
Postdoctoral fellow

An Huang  
Research visitor

The CMSA hosted 40 visiting scholars and faculty throughout the 2017–2018 academic year. So far this year (AY 2018 – 2019), The CMSA has hosted 14 visiting scholars, research associates, fellows & members, as well as 12 postdocs working on topics ranging from symplectic geometry and homological mirror symmetry to cosmology and soft matter physics.

“I have had great opportunities to talk to researchers from various fields. Since my research is related to algebraic geometry and string theory, many discussions with physicists and geometers at CMSA have been very fruitful to me. There are also several symplectic geometers at CMSA who work closely to my field. I have been collaborating with them on several interesting and long-term projects. Finally, CMSA held different mirror symmetry seminars and workshops this year, and this has been extremely beneficial to my research.”

- Jingyu Zhao, CMSA Postdoc



In total, during academic year 2017-18, the CMSA hosted the following events:

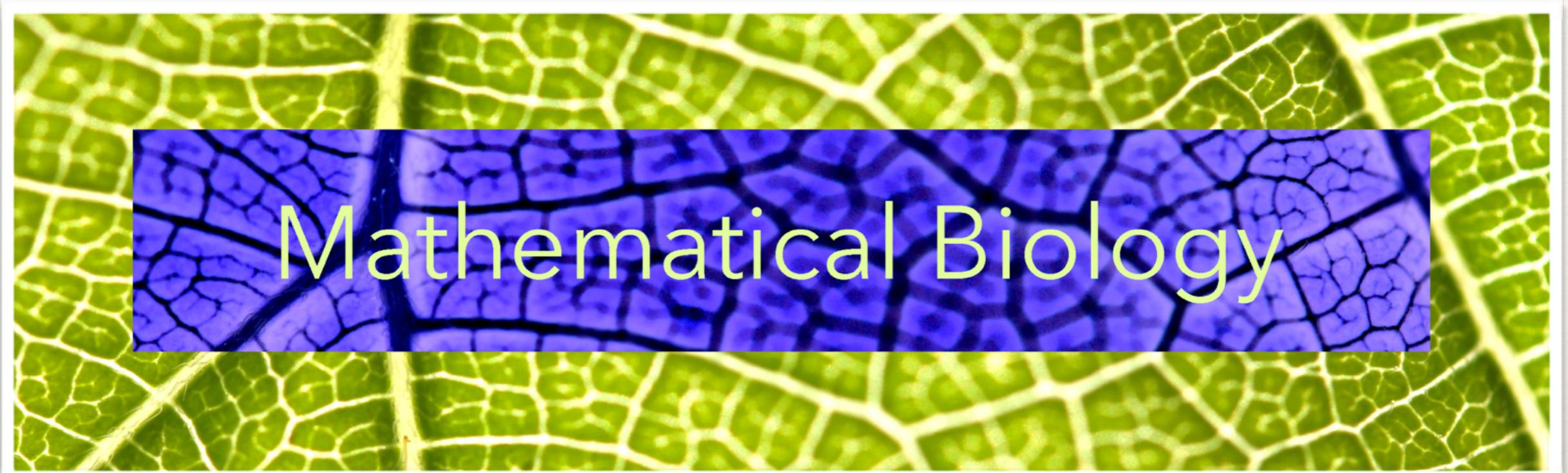
- 19 special lectures by the award-winning mathematician Artan Sheshmani, associate professor, Aarhus University
- 6 social science application forums
- 10 CMSA colloquia
- 10 special seminars
- 24 mathematical physics seminars
- 14 random matrix and probability theory seminars
- 12 homological mirror symmetry seminars and 2 HMS workshop
- 14 Combinatorics and Complexity seminars, workshops, public talks
- 1 public Ding Shum lecture
- 2 public Math Science Lectures in Honor of Raoul Bott
- 3rd Annual Conference on Big Data
- 1 Geometry, Imaging and Computing Workshop
- 1 Quantum Information Workshop

# Seminars & Workshops

---



In addition to Mathematical Physics, Random Matrix and Probability Theory, and Homological Mirror Symmetry, this year we are adding seminars on : Topological aspects of condensed matter, Hodge and Noether-Lefschetz Loci, and Differential and Algebraic Geometry.



## **Special Programs: Mathematical Biology**

---

During the current academic year, the CMSA will focus is running a program that focuses on recent mathematical advances in describing shape using geometry and statistics in a biological context, while also considering a range of physical theories that can predict biological shape at scales ranging from macromolecular assemblies to whole organ systems.

This program will be spearheaded by Prof. L Mahadevan, Lola England de Valpine Professor of Applied Mathematics, and will feature four workshops and several short-term visitors as part of this program



From October 22-24, the Workshop on Morphometrics, Morphogenesis and Mathematics brought together researchers from various institutions (Harvard Medical School, Florida State, Berkeley, and more) to explore the questions related to biomathematics, biophysics, and bioengineering. Talks ranged from modern topology and geometry to theories used for medical applications.

The CMSA will be hosting a second workshop on Mathematical Biology on December 3-6, 2018. This workshop will focus on the interface between morphogenesis and physics.

The Third workshop on Mathematical Biology will take place on April 15-17, focusing on other aspects of the relationship between biology and mathematics.



# **Topological Aspects of Condensed Matter**

## **Special Programs: Topological Aspects of Condensed Matter**

---

New ideas rooted in topology have recently had a big impact on condensed matter physics, and have highlighted new connections with high energy physics, mathematics, and quantum information theory. Additionally, these ideas have found applications in the design of photonic systems and of materials with novel mechanical properties. The aim of this program will be to deepen these connections by fostering discussion and seeding new collaborations within and across discipline.

This program is being lead by Harvard Physics Department Professor Ashvin Vishwanath with help with from Harvard Physics professor Cumrun Vafa and Boston College faculty member Ying Ran. It features a weekly seminar, a rotation of regular visitors, and two workshops.

## **Collaboration with the Harvard Medical School**

The CMSA is planning a mini-symposium on Computational Biology for fall 2019. This event will be cohosted with the Evergrande Center for Immunologic Diseases of the Harvard Medical School. This symposium is at the heart of what the CMSA aims to bring to the international academic community: cross-disciplinary collaboration drawing on the expertise of scientists from multiple fields to create innovative approaches to real life problems. The CMSA was created specifically to create such cooperative events, and this will hopefully be the first of many collaborations between the Evergrande centers at Harvard.

# Collaboration with the Economics Department

The CMSA has been fostering collaboration with economists both at the FAS and Harvard Business School since the creation of its annual Big Data conference in 2015. HBS faculty member Scott Kominers has been a crucial contributor to CMSA programs since its inception, serving as one of the main organizers of the Big Data conference and also organizing regular Social Science Applications Forum seminars and hosting Economic Design Fellows at the CMSA every summer.

The CMSA currently has one postdoctoral fellow and one research associate studying topics in economics. Jörn Bohnke has been affiliated with the CMSA since 2015 and has used his experience as a researcher in computational economics and industrial organization to give many talks at assorted CMSA events, as well as to teach a winter-term class on web scraping. Sergiy Verstyuk works in theoretical finance and artificial intelligence-motivated approaches to behavior economics and is currently in the process of organizing a conference on distributed-ledger (blockchain) technology. This conference is intended to cover a broad range of topics, from abstract mathematics aspects (cryptography, game theory, graph theory, theoretical computer science) to concrete applications (accounting, government, economics, finance, management, medicine).

Nobel Prize winning economist Eric Maskin was the speaker at the 2018 annual Ding Shum lecture, giving a talk on the widely appealing topic of “How to Improve Presidential Elections: the Mathematics of Voting.” Prof. Maskin also contributes to CMSA planning by serving as an official affiliate and is involved in planning future special programs that will further the collaboration between the CMSA and Economics Department.

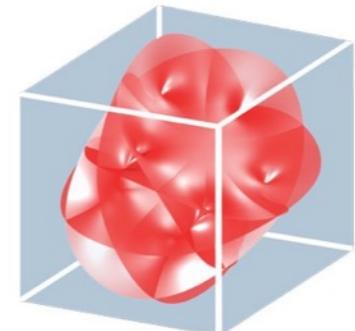
## Publications

---

In addition to over 10 publications by faculty and postdoctoral researchers in AY 17-18 alone, the CMSA has now published two volumes of the CMSA Publication Series on *Nonlinear Analysis in Geometry and Applied Mathematics*. Both volumes reflect the work of the year-long thematic program on nonlinear equations and their connections to geometry, physics, and computer science. This volume presents articles contributed by some of the participants in this program and will benefit scholars working in nonlinear analysis and its connections with geometry and physics.

A third collection on proceedings from the center's Big Data Program is in the early stages of development, and CMSA will be also be starting development on a fourth collection based on the proceedings from the 2017–2018 Program on Combinatorics and Complexity.

Additionally, there is a planned collection based on the programming of this academic year, titled *Current Developments in Mathematics*.



**HARVARD UNIVERSITY  
CENTER OF MATHEMATICAL  
SCIENCES AND APPLICATIONS**

---

### SERIES IN MATHEMATICS

**VOLUME 2**

### Nonlinear Analysis in Geometry and Applied Mathematics, Part 2

Part of the program year 2015–2016 on "Nonlinear Equations"

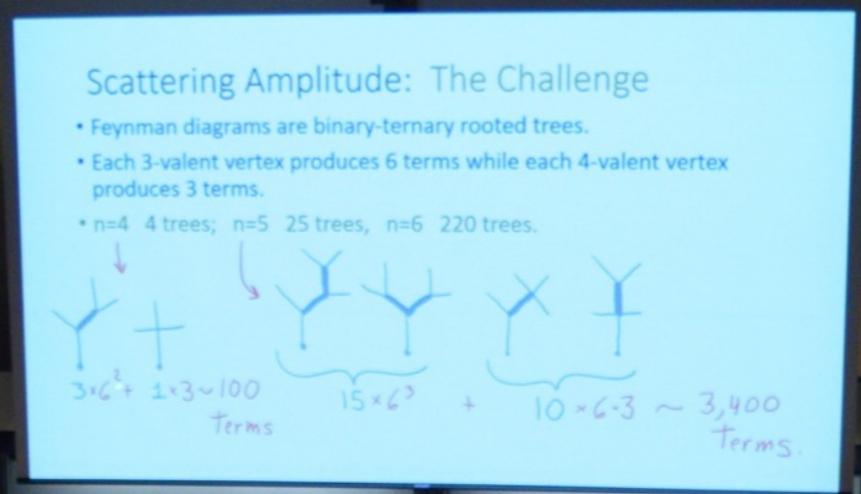
editors

Lydia Bieri      Tristan C. Collins  
Piotr T. Chruściel      Shing-Tung Yau

---

 International Press

# Math Science Lectures in Honor of Raoul Bott, April 2-3, 2018





Kickoff workshop on Kickoff Workshop on Topology and Quantum Phases of Matter, August-27-28, 2018

Workshop on Quantum Information  
April 23-24, 2018

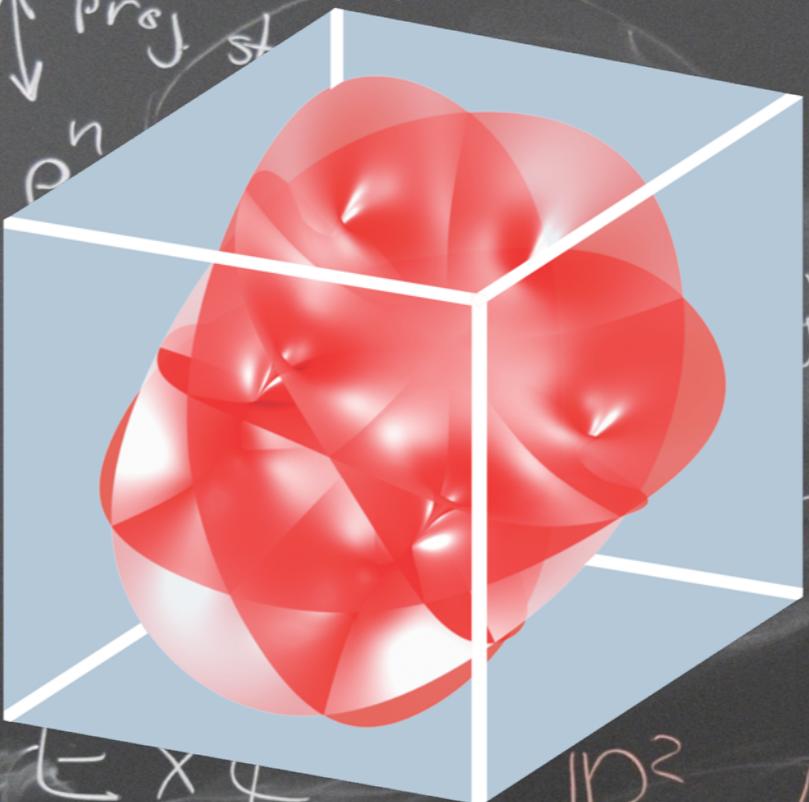




Workshop on Probabilistic and Extremal Combinatorics  
February 5-9, 2018



Participants in From Algebraic Geometry to Vision and AI: A Symposium Celebrating the Mathematical Work of David Mumford, August 18 & 20, 2018



## HARVARD UNIVERSITY CENTER OF MATHEMATICAL SCIENCES AND APPLICATIONS

