DREXEL UNIVERSITY
College of
Arts and Sciences
Mathematics Department

Annual Report 2020-21

Table of Contents

Faculty
Overview

Information and Announcements

Students & Events
Students

Events

Miscellaneous

Leadership Faculty

David Ambrose
Assosciate Department Head
Graduate Advisor

Shari Moskow
Department Head

J. Douglas Wright
Assosciate Department Head

Administration

Paige Chmielewski
Academic
Advisor

Ronald K. Perline
Undergraduate
Advisor

Sobha Philip
Graduate
Program Manager

Kenneth Hemphill
Department
Coordinator

C. Gene Phan
Computer
Specialist

Tenure Stream Faculty

David
Ambrose

Jonah
Blasiak

Robert
Boyer

Patrick
Clarke

Andrew
Hicks

Pawel
Hitczenko

Darij
Grinberg

Pavel
Grinfeld

Yixin
Guo

Georgi
Medvedev

Cecilia
Mondaini

Shari
Moskow

Ronald
Perline

Marci
Perlstadt

Li
Sheng

Eric
Schmutz

Gideon
Simpson

Xiaoming
Song

Hugo
Woerdeman

Douglas
Wright

Thomas
Pok Yin-Yu

Teaching Faculty
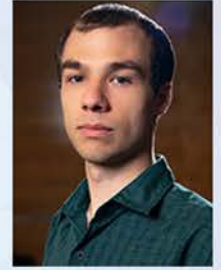
Jason Aran

Fernando Carreon

Daryl Falco

Raymond Favocci

Anatolii Grinshpan

Jeffrey LaComb

Oksana Odintsava

Yasmin B.-Pant

Dimitrios Papadopoulos

Joel Pereira

Adam Rickert

Jeanne Steuber

Kenneth Swartz

K.S. Virbhadra

Richard White

Dennis Yang

Matthew Ziemke

Visiting Faculty

Anuj Abishek

Huseyin Acan

Fazel Hadadifard

Thomas Stojsavljevic

Adjunct Faculty

John Coppola   June Gordon   Boris Kheyfets   Susanne Kriete   Leo Lampone   Brianna Pezzato

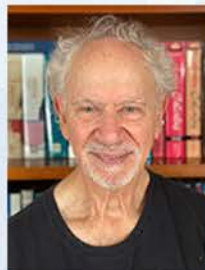Patricia Russel   Valerie Sarris   Patrick Shields   Olga Trubina   Sergio Zefelippo   Kai Zhao

Emeriti Faculty

Howard Anton   Loren Argabright   Robert Busby   William Goh

Chris Rorres   Patricia Russel   Justin Smith   Jet Wimp

Faculty Achievements

Andrew Hicks

Publication:

Elim Hicks, R. Andrew Hicks, Sara G. Rody, & Ronald K. Perline.
 Frobenius Integrability, Automotive Blind Spots, Non-reversing Mirrors, and Panoramic
 Mirrors. American Mathematical Monthly (09 Dec 2021)
 https://opg.optica.org/josaa/fulltext.cfm?uri=josaa-37-9-ED4&id=437649

Darij Grinberg

Publications:

Alberto Dennunzio, Darij Grinberg, Enrico Formenti, & Luciano Margara.
 Chaos and ergodicity are decidable for linear cellular automata over (Z/mZ)&n.
 Information Sciences 539 (2020), pp. 136-144.

Gerard Duchamp, Darij Grinberg, & Vincel H. N. Minh.
 Three variations on the linear independence of grouplikes in a coalgebra arXiv:2009.10970.
 (23 Sep 2020)

Darij Grinberg, Zhi-Wei Sun, & Lilu Zhao.
 Proof of three conjectures on determinants related to quadratic residues.
 Linear and Multilinear Algebra. (02 Dec 2020)

The Elser nuclei sum revisited.
 Discrete Mathematics & Theoretical Computer Science 23 no. 1 (03 June 2021)
 https://doi.org/10.46298/dmtcs.7012

The Pelletier–Ressayre hidden symmetry for Littlewood–Richardson coefficients.
 arXiv:2008.06128. Combinatorial Theory 1 #16 (2021)

Darij Grinberg, Lukas Katthan, & Joel B. Lewis.
 The path-missing and path-free complexes of a directed graph. arXiv:2102.07894. (15 Feb 2021)

Omesh D. Dwivedi, & Darij Grinberg.
 On the rank of Hankel matrices over finite fields. arXiv:2109.05415 (12 Sep 2021)

Presentations:

Darij Grinberg, & Ekaterina A. Vassilieva.
 Weighted posets and the enriched monomial basis of QSym (extended abstract).
 S´eminaire Lotharingien de Combinatoire, 85B.58 (2021), 12 pp. (FPSAC 2021)

Grants, Fellowships, & Awards:

Grant application ("Symmetric functions and quotient rings deforming quantum cohomology") for Simons
Collaboration Grant

NSF Proposal 2054383 ("Symmetric functions and quotient rings deforming quantum cohomology") for
Combinatorics program (program code 7970)

Research in Pairs (joint project with Tom Roby) at Mathematisches Forschungsinstitut Oberwolfach
(18 July 2021 - 07 Aug 2021)

Conference Organizations & Faculty Appointment:

Book reviewer, *Springer*

Yixin Guo

Publication:

Myles Akin & Yixin Guo.
Emergence of Stable Functional Cliques in Developing Neural Networks.
Proceedings of The 10th International Conference on Complex Networks and their
Applications. (Sep 2021)

Cecilia Mondaini

Publications:

N.E. Glatt-Holtz, and C.F. Mondaini.
Mixing Rates for Hamiltonian Monte Carlo Algorithms in Finite and Infinite Dimensions.
arXiv:2003.07980.
Stochastics and Partial Differential Equations: Analysis and Computations. (2021)

N.E. Glatt-Holtz, J.A. Krometis, and C.F. Mondaini.
On the accept-reject mechanism for Metropolis-Hastings algorithms. arXiv:2011.04493 [math.ST],
submitted to Annals of Applied Probability. (29 Nov 2020)

A. Bronzi, R. Guimaraes, and C.F. Mondaini.
On the self-similar blowup for the dissipative SQG equation, in preparation.

Presentations:

Rates of convergence to statistical equilibrium: a general approach and applications.
Colloquium, New Jersey Institute of Technology (NJIT), online. (11 Sep 2020)
Analysis, Dynamics and Applications Seminar, University of Arizona, online. (22 Sep 2020)
Differential Equations Seminar, U of Maryland Baltimore County (UMBC), online. (12 Oct 2020)
Center for Nonlinear Analysis Seminar, CMU, online. (22 March 2021)
Applied and Computational Math Seminar, UW Madison, online. (02 April 2021)
Probability, Analysis and Data Science Seminar, Iowa State University, online. (07 April 2021)

Numerical Approximation of the invariant measure for 2D stochastic Navier-Stokes equations,
AMS Fall Central Sectional Meeting (formerly at University of Texas at El Paso), Special Session on
Theoretical and Computational Studies of PDEs related to Fluid Mechanics, online. (12-13 Sep 2020)
AMS Fall Western Sectional Meeting (formerly at University of Utah), Special Session on
Recent Advances on the Theory of Fluid Dynamics, online. (24-25 Oct 2020)
SIAM CSE21,
Minisymposium "Computational Dynamics meets Computational Statistics" online. (03 Mar 2021)

Mixing for Hamiltonian Monte Carlo in infinite dimensions,
AMS Fall Western Sectional Meeting (formerly at University of Utah), Special Session on
PDEs, Data and Inverse Problems, online. (24-25 Oct 2020)

Hamiltonian Monte Carlo in infinite dimensions: mixing and generalizations,
Joint Mathematics Meetings, Special Session on
"Geophysical Fluid Dynamics, Turbulence, and Data Assimilation: A Rigorous and Computational Study",
online. (07 Jan 2021)

Grants, Fellowship, & Awards:

NSF proposal(2021)

Grant proposal, Instituto Serraphilheira, Brazil (2020)

Conference Organizations & Faculty Appointments:

Co-organizer, *MCMC/Statistical Sampling online reading/working seminar,*
    Fall 2020 - present
Co-organizer, MCA 2021 conference, *New Developments in Mathematical Fluid Dynamics*
    July 12-23 (online)
Co-organizer, SIAM DS21 conference, *Mathematics of Fluids: Analysis and Computations*
    May 23-27 (online)
Panel member, INCTMat rountable discussion, *Writing Proposals*
    November 4, 2020

Student Activities:

Mathilda Nguyen, Drexel, Summer 2021 – present
  Project: Rates of convergence for MCMC algorithms applied to toy models.

Raymond Langer, Western U, Canada, Summer 2021
  Project: Numerical simulations of a control-type data assimilation algorithm for the KdV equation.

Ricardo Martins Guimarães, Unicamp, Brazil, 2019 – present
  Project: Non-existence of self-similar solutions for the supercritical surface quasi-geostrophic equation.
(jointly advised with Anne Bronzi, Unicamp, Brazil).

Robert Scholle, Drexel, 2019 – 2021 (resigned to seek job opportunities in industry)
  Project: MCMC algorithms applied to Bayesian inverse ODE problems.

Shari Moskow
Publications:

A. Abhishek, M. Bonnet, S. Moskow.
    Modified forward and inverse Born series for the Calderon and diffuse-wave problems.
    Inverse Problems, 36 #11. (2020)

V. Druskin, S. Moskow and M. Zaslavsky.
    Lippmann-Schwinger-Lanczos algorithm for inverse scattering problems.
    Inverse Problems, 37 #7. (2021)

Eric Schmutz
Publication:

Huseyin Acan, Charles Burnette, Sean Eberhard, James Thomas, Eric Schmutz.
    Permutations with equal orders, Combinatorics, Probability, and Computing 30. (2021)

Thomas Yu
Publications:

J. Chen, T. P.-Y. Yu, P. Brogan, R. Kusner, Y. Yang, A. Zigerelli.
    Numerical Methods for Biomembranes: conforming subdivision versus non-conforming
    {P}{L} methods. Mathematics of Computation 90. (2021) pp. 471-516

Jingmin Chen, Thomas Yu.
    On the Uniqueness of Clifford Torus with Prescribed Isoperimetric Ratio.
    arXiv:2003. 13116. (2021)

Hugo Woerdeman

Publications:

Book: Linear Algebra: What you Need to Know. 259 + xxi pages, CRC Press, 2021

Jeffrey S. Geronimo, Hugo J. Woerdeman, Chung Wong.
   Spectral density functions of bivariable stable polynomials,
   Ramanujan J. 56. (2021) pp. 265–295.

Stefan Sremac, Hugo J. Woerdeman, Henry Wolkowicz.
   Error Bounds and Singularity Degree in Semidefinite Programming.
   SIAM J. Optim. 31 (2021). pp. 812--836.

Kennett L. Dela Rosa, Hugo J. Woerdeman.
   Continuity of submatrices and Ritz sets associated to a point in the numerical range.
   Linear Algebra Appl. 624 (2021), pp. 1-13.

Edward Poon and Hugo J. Woerdeman.
   Isospectrality and matrices with concentric circular higher rank numerical ranges.
   Linear Algebra Appl. 631 (2021), pp. 174-180.

Ben Grossmann and Hugo J. Woerdeman.
   Fractional minimal rank, Linear and Multilinear Algebra 69 (2021). pp. 19–39.

Presentations:

Error Bounds and Singularity Degree in Semidefinite Programming.
   Operator Theory and Matrix Analysis (OTMA), online conference. (Nov 2020)

The autoregressive filter problem for multivariable degree one symmetric polynomials.
   2021 Joint Meetings of the American Mathematical Society and the Mathematical Association of America,
      online conference. (Jan 2021)
   Online Seminar Linear Algebra and Operator Theory (Oselot), online. (Jan 2021)
   University of Nevada, Reno, Colloquium. (April 2021)

Classical and Multivariable Toeplitz Matrices: Completions and Other Aspects.
   Workshop on Distance Geometry, Semidefinite Programming and Applications.
      The Fields Institute. (May 2021)

Grants, Fellowship, & Awards:

Simons Foundation Collaboration Grant 355645 (2015-2021)
   The multivariable Schur class and determinantal representations. $35,000

NSF Grant DMS 2000037 (2020 - 2023)
   Modern Aspects of Multivariable Operator Theory and Matrix Analysis. $249,000

Conferences & Faculty Appointments:

Editor-in-Chief, Matrices and Operators.

Associate Editor of Annals of Functional Analysis.

Vice President, International Linear Algebra Society

Vice President, Steering Committee
   International Workshop on Operator Theory and its Applications.

Student Activities:

Kennett Dela Rosa,
  Location of Ritz values in the numerical range of normal matrices.
  2021 Joint Meetings of the American Mathematical Society and the Mathematical Association of America, online conference. (Jan 2021)

Yaqi Zhang,
  Finding Needles in Haystacks: Approaches to Inverse Problems using Combinatorics and Linear Algebra.
  AMS Mathematics Research Communities workshop, online. (2020-21)

Michael Becht and Pedro Frazao (research co-op),
  The Spectral Radius of a Class of Matrices.
  The Tracial Moment Problem.

Service Recognition

Fifteen Years of Service:

Five Years of Service:

Yixin
Guo

Daryl
Falco

Anatolii
Grinshpan

Matthew
Ziemke

Faculty Recognition

Castle Fellow:

Dimitrios
Papadopoulos

Departmental Service Assignments 2020-21

Tenure and Promotion

Chair: Thomas Pok-Yin Yu
All tenured faculty

Graduate Admissions Committee

Chair: Gideon Simpson Cecilia Mondaini
Xiaoming Song Darij Grinberg
Associate Head: David Ambrose

Graduate Program Committee

Chair: David Ambrose Yixin Guo
Hugo Woerdeman Robert P. Boyer

Undergraduate Program Committee

Chair: Hugo Woerdeman Matthew Ziemke
Ronald Perline Marci Perlstadt
Fernando Carreon Jason Aran
Associate Head: Douglas Wright

Undergraduate Recruitment Committee

Chair: Dimitrios Papadopoulos
Ronald Perline
Jeffrey LaComb

Teaching Faculty Promotion

Chair: Oksana Odintsava
Pavel Grinfeld
All teaching faculty Associate or higher

Postdoc Search Committee

Chair: Xiaoming Song
Cecilia Mondaini
Georgi Medvedev

Remote Teaching Aid Committee

Chair: Raymond Favocci Fernando Carreon
Jason Aran Daryl Falco
Dimitrios Papadopoulos Cecilia Mondaini
Matthew Ziemke Jeffrey Lacomb

Transfer Credits

Li Sheng

Assistant Scheduler

Andrew Hicks

Colloquium Coordinator

Georgi Medvedev

Distinguished Speaker Coordinator

Ronald Perline

Library Liason

K. S. Virbhadra

Math Competition Coordinator

Darij Grinberg

MSO Faculty Advisor

Jason S. Aran

Actuarial Society Faculty Advisor

Marci Perlstadt

Pi Day Coordinators

Adam Rickert
Daryl Falco
Jason Aran

Diversity, Equity, & Inclusion Committee

Chair: Shari Moskow
K.S. Virbhadra
Thomas Pok-Yin Yu
Pavel Grinfeld

Course Coordination

MATH100: Raymond Favocci
MATH101: Oksana Odintsava, Yasmin B-Pant
MATH102: Anatoli Grinsphan
MATH105: Jeanne Steuber
MATH116: Jason Aran, Fernando Carreon
MATH121: Jeffrey LaComb, Matthew Ziemke
MATH122: Kenneth Swartz, Dennis Yang
MATH200: Dimitrios Papadopoulos

In Memory of Charles Mode

Charles Mode was a Professor Emiritus of Mathematics. As a professor of Drexel from 1970 - 1988, students flourished under his tutlelage and contributions in fields related to statistics - due to his initial background in plant genetics. He was known by his students and colleagues to be a gentleman that genuinely cared. He will be missed by us all.

Happy Retirement to Harold Gilman

Professor Harold Gilman started at the evening college as an adjunct faculty in 1958. In 2010, Pat Henry invited him to teach day classes, in the mathematics department. He worked at Drexel for 62 years. The department and the college is grateful for his sincere hard work and dedication and wish him the very best for his retired life.

Thank You to Yilin Yang
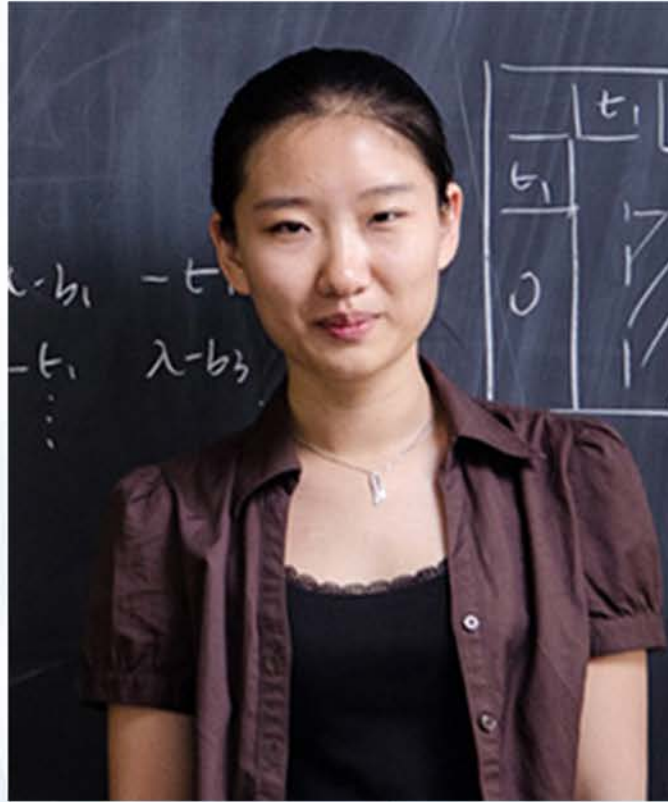
Yilin Yang graduated Drexel in 2017 with a Bachelor's in Mathematics, Masters from MIT, and currently works at Microsoft. The department could not be more proud of her achievements and success in life and career.

We are extremely grateful for her generous contributions back to the Drexel math community to be presented to students who excel in research.

Teaching & Research Assistants

Roselyn
Adkisson
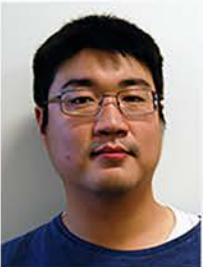
Sultan
Aitzhan

Udoh
Akpan

Adam
Baurkot

Patrick
Bray

Luke
Brown

Wonsang
Cho

Liam
Doherty

Alexander
Joseph Furia

Sarah
Gift

Anthony
Grabow

Eammon
Hart

Benjamin
Irwin

Amanda
Johnson

Aiza
Kabeer

Emily
Kay Kelting

Hyeju
Kim

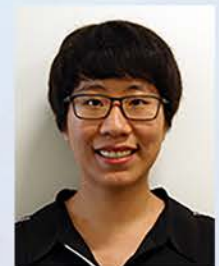Dominick
Macaluso

Joshua
McGinnis

Anya
Pant

Kennett L.
Dela Rosa

Robert
Scholle

Isaac
Woods

Yaqi
Zhang

PHOTO
UNAVAILABLE

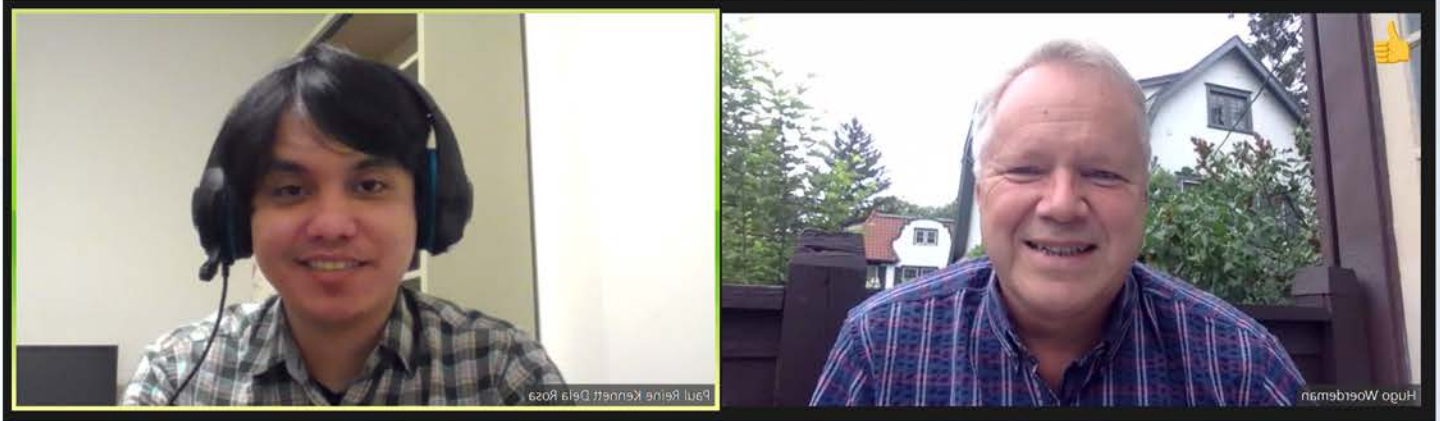# Congratulations New Doctors!

On May 24, 2021, Kennett L. Dela Rosa (left) successfully defended their thesis -
Ritz Values and the Free Joint Numerical Radius
- under Professor Hugo Woerdeman PHD (right)

On June 10, 2021, Benjamin Irwin (left) successfully defended their thesis -
An Abstract Cauchy-Kovalevskaya Theorem for the Mean Field Games System
- under Professor David Ambrose PHD (right)

Graduate & TA Honors & Awards

University-Wide Continuing Excellence in Teaching Assistance Award:
There is a real tradition of excellent teaching amoung our graduate students and it is great to see it recognized

Dominick Macaluso, PHD in Mathematics

Departmental Al Herr "TA Excellence" Award:
There is truly a culture of excellence among our TAs and this year's winners get to carry this banner of achievement

A.J. Furia   **Dominick Macaluso**

CoAS Interdepartmental Student Research Showcase, Third Prize:
In our spring 2021 research showcase, students are awarded prizes for stellar academic presentations. This year we celebrate "The Dynamics of Lattice Systems with Random Components" by:

Joshua McGinnis

Graduate Student Publication:
Aitzhan, S., Bhandari, S. & Smith, D.A. Fokas Diagonalization of Piecewise Constant CCoefficient Linear Differential Operators on Finite Intervals and Networks. Acta Appl Math 177, 2 (2022). https://doi.org/10.1007/s10440-021-00456-9

Sultan Aitzhan

Undergraduate Honors & Awards

Robert J. Bickel Scholarship:
Presented in honor of Dr. Robert J. Bickel, who was a member of the mathematics department from 1946 to 1987

Omesh Dwivedi	Chelsea Gravereaux	Justin Gliksman
Liane Lech	Mikey Becht	Pedro Frazao
Rishi Patel	Sadia Afrin	Sopheap Kim

Frank H. M. Williams Prize in Mathematics:
Presented annually in regonition of academic achievement in mathematics

Yimei Li

Dr. Robert C. Busby Mathematics Award:
Funded in honor of Dr. Robert C. Busby, who was a member of the mathematics department at Drexel from 1966 to 1968, 1970 to 2003. Presented to an outstanding undergraduate mathematics major woh volunteers their time as a mentor or tutor

Ken Deng Frank

Yang Award for Outstanding Undergraduate Research in Mathematics:
Presented annually in honor of Ms. Yilin Yang to students who excel in research

Nicholas DeFelippis

Graduating Class of 2020-21

Bachelor of Science & Arts

Kelsey Nicole Bray
Seamus Patrick Steele
Henrey Williams
Nichollas Oberto
Yasmeen R. Kelly
Vanessa Margaret Munley
Yuanhao Lan
Anna Elizabeth Wilson
Yegen Pylypchenko
Rishi M. Patel
Jeff Monroe Winchell
Mehmet Birtan Derin
Manas Bharadwaaj Subramanian
Sanskriti J. Seernani
Marius Andrei Stefan Garbea
Brain P. Mansfield
Yimei Li
Kuanyu Lai
Andrea M. Umali
Joseph Peter Cavaliere
Issa Ghassan Asfatoun

Master of Science

Anthony Grabow
Robert Scholle

Co-Op Employers 2020-21

Drexel University
Earth Engineering, Inc.
Harmony Biosciences
SAP America
Professional Development II
DecoPro
Health Union LLC
Intern NZ
Publicis Health
JobDiva
Point72
BEB Capital LLC
Two Six Labs
Odin Properties LLC
Cozen O'Connor
National Board of Medical Exam
Penn State University
Cornerstone Capital Planning Group
The Opes Group
Thomas Scientific
Megger
Lockheed Martin
Venerable
NRG Northeast Retail
Twenty Acre Capital
Bristol Myers Squibb Company
Group One Trading
Sapient Industries, Inc.
Independence Blue Cross
Orrstown Bank

SIAM 2020-21

The 2020-2021 academic year of SIAM was a testament to our department & graduate students resiliance with our second year of the pandemic. SIAM meetings continued after postponement of last year's meetings solely online, and a few of our graduate students spoke at the 11th Annual Epsilon Talks. Although short, students should remember SIAM 2020-2021 as the year that encapsulated that ambition, & knowledge, can't wait.

10/14/20: **Joshua McGinnis:**
Establishing the Existence of Wavelike Behavior in an FPUT System with Random Coefficients

10/28/20: **Emily Kay Kelting:**
Ion-Acoustic Wave Dynamics Based on a Nonzero Electron Mass

01/27/21: **Dominick Maculoso:**
Traveling Front Stability Analysis for a Non-Saturating Piecewise Linear Gain Function

02/24/21: **Patrick Bray:**
D-Bar Reconstruction for Electrical Impedance Tomography

04/15/21: **11th Annual Epsilon Talks - Amanda Johnson:**
Why are Big Data Matrices Approximately Low Rank

04/15/21: **11th Annual Epsilon Talks - Patrick Bray:**
Inverse Problems and Regularization Methods

04/15/21: **11th Annual Epsilon Talks - Liam Doherty:**
Parallelized Physics Simulations in Julia

04/29/21: **Kennett Dela Rosa:**
Completing an Operator Matrix and the Free Joint Numerical Radius

05/01/21: **Kennett Dela Rosa:**
Continuity of Submatrices and Ritz Sets Asssociated to a Point in the Numerical Range

Seminars & Talks 2020-21

🟩 **Colloquium** 🟥 **PDE Seminar** 🟨 **CAGE Seminar**

10/14/20: **Darij Grinberg (Drexel University):**
Littlewood-Richardson Coefficients and Birational Combinatorics

10/21/20: **Andrew Hicks (Drexel University):**
Igenmirrors and Eigensurfaces

11/04/20: **Georgi Medvedev (Drexel University):**
Bifurcations and Patterns in the Spatially Extended Kuramoto Model

11/18/20: **David Ambrose (Drexel University):**
Global Existence Results for the 2D Kuramoto Model

12/02/20: **Hugo Woerdeman (Drexel University):**
The Autoregressive Filter Problem for Multivariable Polynomials

02/03/21: **Shari Moskow (Drexel University):**
Reduced Order Models for Spectral Domain Inversion

01/30/21: **Thomas Stojsavljevic (Drexel University):**
Mathematical Modeling of Phytoplankton Distributions in Freshwater Ecosystems

02/25/21: **Anna Pun (University of Virginia):**
A Shuffle Theorem for Paths Under Any Line

03/04/21: **Anna Pun (University of Virginia):**
A Shuffle Theorem for Paths Under Any Line Pt. II

04/11/21: **Claudia Yun (Brown University):**
The S_n-equivariant rational homology of the tropical moduli spaces \Delta_{2,n}

05/13/21: **Yusra Naqvi (University College of London):**
Interpolation Polynomials and Bar Games

MSO 2020-21

*The 2020 - 21 year of the **Math Student Association** (dubbed 'MSO') showcased the many ways that mathematics is applied in the common world by students - from poker to rubix cubes, as well as discussion on challenging problems*

Omesh Dhar Dwivedi (President)
Alisha Augustin (Vice President)
Sanskriti Seernani (Treasurer)
Kayne Gaylie (Event Coordinator)

MRC 2020-21

In the 2020-21 academic year, due to restrictions imposed by the pandemic, the Math Resource Center was not available for face-to-face tutoring on campus - rather open for Drexel students online through the Zoom platform. Thus, the Math Resource Center increased its outreach to students regardless of their physical location. With the help of faculty, TA, and student stutors, the center served 3729 students using the zoom platform. The center was open Monday - Thursday from 10 AM to 7 PM and 10 AM - 4 PM on Friday. The resource center created a coop job opportunity for Drexel students and every quarter two students worked at the center as part-time employees.

Visits by Week

Week	Visits
WEEK 1	25
WEEK 2	94
WEEK 3	128
WEEK 4	128
WEEK 5	133
WEEK 6	124
WEEK 7	112
WEEK 8	99
WEEK 9	104
WEEK 10	85