National Association of Mathematicians

Newsletter

Volume LII Number 1 Spring 2021

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Celebrating Dr. James Donaldson at the JMM, Virtually

Virtual attendees at the AMS-NAM Joint Special Session Celebrating the Legacy of Dr. James A. Donaldson, organized by Dr. Caleb Ashley, Dr. Naiomi Cameron, Dr. Bourama Toni, and Dr. Talitha Washington

The National Association of Mathematicians (NAM)
publishes the NAM Newsletter four times per year.

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NAM's History and Goals: The National Association of Mathematicians, Inc. (known as NAM) was founded in 1969. NAM, a nonprofit professional organization, has always had as its main objectives, the promotion of excellence in the mathematical sciences and the promotion and mathematical development of under-represented minority mathematicians and mathematics students. It also aims to address the issue of the serious shortage of minorities in the workforce of mathematical scientists.

NAM's National Office, subscriptions and membership: National Association of Mathematicians, 2870 Peachtree Rd NW #915-8152, Atlanta, GA 30305; e-mail: info@nam-math.org.

NAM's Official Webpage: http://www.nam-math.org

Newsletter Website: The NAM website has a list of employment as well as summer opportunities on the Advertisements page. It also features past editions of the Newsletter on the Archives page.

Letters to the editor and articles should be addressed to Dr. Omayra Ortega via e-mail to editor@nam-math.org.

From the Editor

"Confront the dark parts of yourself, and work to banish them with illumination and forgiveness. Your willingness to wrestle with your demons will cause your angels to sing."
— August Wilson

Hello friends,

As I registered for the Joint Mathematics Meetings (JMM) I was worried about how effective my annual sojourn to the largest annual math meeting would be in the virtual environment, but I was not disappointed. This year, the JMM was the re-energizing and reflective experience that I needed! I learned about new research discoveries, attended a wonderful crop of introspective a socially concious workshops, reconnected with geographically far-flung colleagues, and attend many business meetings. I rely on this annual sojourn for motivation, it is my annual New Year's celebration – complete with New Year's Resolutions. Everyday is a new day to do better.

My heart was filled during the AMS-NAM Joint Special Session Celebrating the Legacy of Dr. James A. Donaldson. It was wonderful to hear folks wax nostalgic about what an amazing human being this co-founder of NAM was. Always my favorite, the Haynes-Granville-Browne Recent PhDs session, put a spotlight on the newest members of our community. NAM plans to join the Joint Meetings as a Level A partner to provide consistent programming and discounted registration rates for our members.

This will be my last issue as your editor. This has been a wonderful journey with you, and I look forward to continuing my service as the President of the National Association of Mathematicians.

Be well,
Dr. Omayra Ortega

Publishing in the NAM Newsletter

Submissions: The *NAM Newsletter* is a quarterly publication. Articles and letters should be submitted electronically to the editor at `editor@nam-math.org`. You can find more information at the web page

`https://www.nam-math.org/submitting-advertisements-and-articles.html`

Advertising:

NAM Online Advertisement Policy: As a part of its Newsletter Advertising, a copy of the advertisement will be placed on the web during the period it appears in the quarterly Newsletter - at the Job Openings website.

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A. One-fourth page	$200
B. One-third page	$300
C. One-half page	$400

D. Two-thirds page	$500
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2. Consecutive, multiple issue advertising

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Deadlines: The deadlines for submissions and advertisements can be found in the following table.

Edition	**Deadline**
Spring	February 13
Summer	May 13

Edition	**Deadline**
Fall	August 13
Winter	November 13

Advertisements should be submitted electronically to the editor at `editor@nam-math.org`.

We reserve the right to reject any advertising that is not consistent with the stated goals of NAM, or that is in any way deemed inappropriate.

Revised 11/19

2021 Joint Mathematics Meetings

by Omayra Ortega

The National Association of Mathematicians organized several sessions at the 2021 Joint Mathematics Meeting. This article serves as a summary of the sessions organized by NAM.

Dr. Chelsea Walton

Dr. Chelsea Walton (Rice University) gave the 2021 Clayton-Woodard Lecture titled, *An Invitation to Noncommutative Algebra*. This talk delved into the wonderful world of Noncommutative Algebra, primarily discussing the roles of Symmetry, Representations, and Deformations in this area of mathematics. The talk contained a mix of classical results, the speaker's research contributions, as well as open questions and entertaining anecdotes in this very active area of research. It was based on the Dr. Walton's survey article of the same title, published in the 2019 EDGE program volume for the AWM Springer series.

There were four talks given by recent PhDs in the Haynes-Granville-Browne Session of Presentations by Recent Doctoral Recipients.

- Aqeeb Sabree (Xavier University) *Positive Definite Kernels, Harmonic Analysis, and Boundary Spaces: Drury-Arveson Theory, and Related*
- Enahoro Iboi (Spelman College) *The Fight to Curtail the Spread of the Novel Coronavirus in the U.S*
- Dwight Williams II (Iowa State University) *Relations, parity, and super representation theory*
- Lori D Watson (Wake Forest University) *On isolated points of odd degree on $X_1(N)$*
- Aubain Hilaire Nzokem (York University) *SIS Epidemic Model : Birth-and-Death Markov Chain Approach*
- Derek Young (Mount Holyoke College) *The Maximum Nullity and Zero Forcing Number of a Graph*

Dr. Lori D. Watson

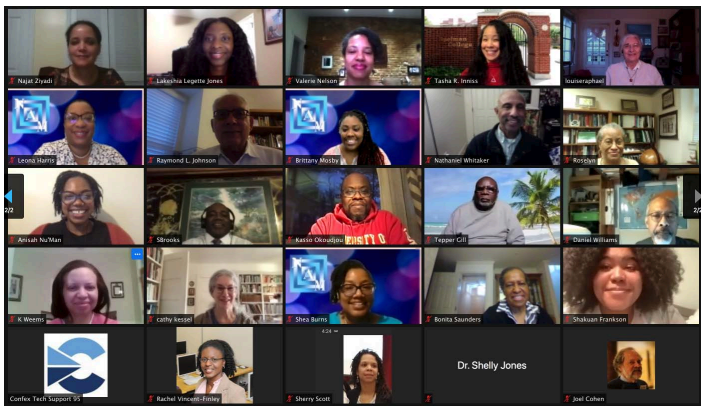
Dr. Lori D Watson, Wake Forest University, won the NSF Math Institutes Prize for outstanding presentations by a recent PhD.

Dr. Talitha Washington

On Thursday January 7, 2021 Dr. Talitha Washington (Atlanta University Center) gave the 2021 Cox-Talbot lecture titled, *Leveraging Data Science at HBCUs to Advance Innovation.* Dr. Washington explained how HBCUs have been central to the production of mathematicians of African descent and demonstrated how HBCUs are precisely the institutions to meet the increasing demand for students trained in data science. With the abundance of data, new skills will be needed to prepare students for jobs that do not yet exist. As we develop new data science tools and platforms, innovations in research are needed to advance the field of data science. Historically Black Colleges and Universities (HBCUs) have the unique opportunity to develop novel ways to address ethics and bias issues associated with data science research. As mathematics is a cornerstone of data science, this presentation shared recent advancements in data science at HBCUs and how policy encourages advancement in the data science innovation ecosystem.

Group shot from the Celebrating James Donaldson session

On Friday January 8, 2021 NAM co-sponsored the AMS-NAM Joint Special Session, *Celebrating the Mathematical Legacy of Dr. James A. Donaldson*, a workshop co-organized by Dr. Naiomi Cameron, Dr. Caleb Ashley, and Dr. Tepper Gill.



Group shot from the Celebrating James Donaldson session

Omayra Ortega *Omayra Ortega is the President of the National Association of Mathematicians. She can be reached at* `mailto:president@nam-math.org`. □

AWM Honors Raegan Higgins with Humphreys Award for Mentoring

AWM Newsletter

Dr. Raegan Higgins-Siwatu

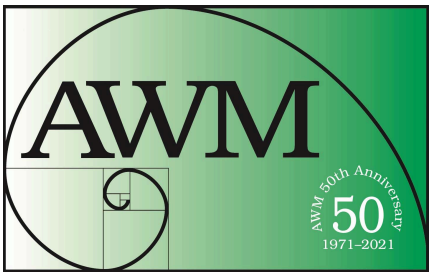
This is a reprint of the AWM Media Release published in the January-February 2021 AWM Newsletter https://awm-math.org/wp-content/uploads/2021/10 /AWM-News-JanFeb-2021-PRINT.pdf

The Association for Women in Mathematics is pleased to present the 2021 Gweneth Humphreys Award to Raegan Higgins, Associate Professor of Mathematics in the Department of Mathematics and Statistis at Texas Tech University. Raegan Higgins has a PhD in Mathematics from the University of Nebraska and her research interests revolve around timescales — particularly oscillation criteria for certain linear and nonlinear second order dynamic equations. She has also studied the impact of professional development on the self-efficacy of middle-school mathematics teachers.

At Texas Tech University, Higgins' excellence in teaching and mentoring and her commitment to diversity have consistently shined through. In addition to her formal role as academic advisor for both female and male graduate students, she co-founded the Young Women in Mathematics: Fostering Success program in 2013. This initiative led to the formation of an AWM Student Chapter in 2018 which Higgins co-advises. She is also a member of the organizing committee of the Emmy Noether High School Mathematics Day and over the years has given numerous talks, organized workshops, and served as Career Panelist for the female high school and undergraduate students who participate in this annual event. Since 2009, Raegan Higgins has served as Faculty Advisor for the Eta Lambda Chapter of Delta Sigma Theta Sorority and as Faculty Mentor and Mentor Cluster Leader for Mentor Tech (formally known as The Lauro Cavazos & Ophelia Powell-Malone Mentoring Program), a program for students from diverse backgrounds at Texas Tech. In 2014, Higgins received a Women in STEAM Award from the Center for the Integration of STEM Education and Research and in 2020 she was recognized as an Integrated Scholar for her synergistic activities at the] intersection of

teaching, service and research.

An alumna of the Enhancing Diversity in Graduate Education (EDGE) program, and one to always give back, Higgins served as EDGE Instructor in the years 2014 to 2017 and since 2017 serves as co-director of the program. Founded in 1998, the EDGE program has had a marked success at helping female undergraduate mathematics students transition into and thrive in graduate school. Raegan Higgins is a co-founder of the Network of Minorities in Mathematical Sciences. Through its website Mathematically Gifted and Black, the network highlights the contributions and accomplishments of blacks in the mathematical sciences.



Raegan Higgins has positively impacted the academic trajectory of many women, particularly women of color, within and outside of her institution and the AWM is pleased to honor her for her genuine and sustained commitment to the recruitment, mentoring, and retention of women in mathematics.

This award is named for M. Gweneth Humphreys (1911–2006). Professor Humphreys earned her master's degree from Smith College and her PhD at age 23 from the University of Chicago in 1935. She taught mathematics to women for her entire career, at Mount St. Scholastica College, Sophie Newcomb College, and finally for over thirty years at Randolph-Macon Woman's College. This award, funded by contributions from her former students and colleagues at Randolph-Macon Woman's College, recognizes her commitment to and her profound influence on undergraduate students of mathematics.

The AWM Newsletter *is a publication of the Association for Women in Mathematics (AWM). The AWM can be reached at* `awm@awm-math.org`. □

SIAM Welcomes First Vice President for Equity, Diversity, and Inclusion

SIAM Newsletter

This is a reprint of the SIAM Media Release published on the SIAM websiter https://sinews.siam.org/Details-Page/siam-welcomes-first-vice-president-for-equity-diversity-and-inclusion

SIAM welcomes Ron Buckmire, Associate Dean for Curricular Affairs and Professor of Mathematics at Occidental College (Oxy), as the organization's first Vice President for Equity, Diversity, and Inclusion (EDI). The primary focus of the Vice President for EDI is to expand SIAM membership across all demographics and establish an ethos of equity and inclusion throughout all SIAM programs and activities, ensuring that SIAM is serving its entire diverse community.

In his current role, Ron is the member of the academic affairs leadership team who oversees all aspects of Oxy's curriculum. He has more than four years of service in the federal government as an employee of the National Science Foundation (NSF) from 2011-2013 and 2016-2018. There he was Lead Program Director of the NSF Scholarships for Science, Technology, Engineering and Mathematics (S-STEM) program housed in the Division of Undergraduate Education and a permanent Program Director responsible for undergraduate mathematics education. He has been on the Oxy faculty since 1994, serving as Chair of the Oxy Mathematics Department twice (2005-2010, 2015-2016) and achieving the rank of Full Professor in 2014 after beginning his academic career at Oxy as a Minority Postdoctoral Scholar-in-Residence. Ron holds mathematics degrees (Ph.D., M.Sc., and B.Sc.) from Rensselaer Polytechnic Institute in Troy, New York.

Dr. Ron Buckmire

"I'm very excited to serve as SIAM's first Vice President for Equity, Diversity, and Inclusion, especially with incoming Executive Director Suzanne L. Weekes, a longtime colleague and friend," said Ron. "In my career as an educator, researcher, and professional, I have always felt the most comfortable with SIAM, and I relish the opportunity to align my efforts with Suzanne's to make SIAM the most equitable, diverse, and inclusive it can be."

In this cabinet-level position, the Vice President for EDI will be a voting member of the SIAM Council, and will work side-by-side with SIAM leadership and the Vice

Presidents for Industry, Education, Publications, Science Policy, and Programs, as well as members of the Diversity Advisory and Membership Committees.

"Equity, diversity, and inclusion should flow through every vein of SIAM. As such, a voice dedicated to EDI should be at every Council and Board meeting, where policies are set and financial decisions are made," said Lisa Fauci, SIAM President. "We are excited to welcome Ron in this important role and believe his experience aligns with the core responsibilities and goals of this new position."

Ron served on the SIAM Education Committee for many years, has been a member of SIAM's Diversity Advisory Committee since 2015, and is currently the Chair of SIAM's Membership Committee. As Program Director of the SIAM Activity Group on Applied Math Education, Ron was co-chair of the cancelled 2020 SIAM Conference on Applied Mathematics Education.

He is a passionate advocate for broadening the participation of underrepresented individuals in mathematics and other STEM disciplines and a strong believer in the importance of liberal arts education in the creation and sustenance of an equitable, just, and thriving civil society.

Ron will serve as Vice President for EDI January 1, 2021 through December 31, 2022.

SIAM News *is a publication of the Society for Industrial and Applied Mathematics (SIAM). The SIAM News can be reached at* `sorg@siam.org`. □

Generativity in Mathematics, Nurturing the Next Generation: A Tribute to Innis, Scott, Weems and Johnson

Jacqueline Brannon-Giles

Erik Erikson defined the concept called "generativity" as "a concern for establishing and guiding the next generation." Generativity was witnessed in the Webinar featuring Dr. Tasha R. Innis, Dr. Sherry E. Scott, and Dr. Kimberly S. Weems. Three doctors were interviewed and celebrated in a virtual meeting on December 21, 2020. They were honored 20 years after their historical accomplishment of receiving PhDs

Dr. Raymond Johnson with Dr. Jacqueline Brannon-Giles

in mathematics from the University of Maryland. The three beautiful, young scholars and professional mathematicians were questioned by one of their mentors, Dr. Raymond Johnson. I also respect and honor Dr. Johnson because my term as a MAA Board of Governor's member was juxtaposed by his term on the MAA Board of Governors. His term preceded my term as the representative for Minority Affairs. I was impressed by the interview because Dr. Johnson's academic and professional experiences helped to vicariously nurture me. We both were born in Texas. In 1961 I was advised to not apply to Rice University because the environment was perceived to be non-welcoming. Years later, I would encourage my daughter to apply to Rice University and she graduated, enjoyed her journey, and now works as an econometrician in the public sector. In some ways, I learned to apply the concepts of generativity that I observed in the career of Dr. Raymond Johnson.

The MAA Secretary's Report, by Martha Siegel, stated, "With this meeting the Board welcomed Frank Farris, the new Editor of Mathematics Magazine. We bid goodbye to outgoing governors: Raymond Johnson of the University of Maryland, who is being replaced by Jacqueline Giles of Houston Community College as the Governor-at-Large for Minorities..." MAA Secretary's Report — Mathematical Association of America Raymond Lewis Johnson — Mathematical Association of America (maa.org). As you read about the life and career of Dr. Johnson you realize the legacy he has inspired by sharing knowledge and wisdom with the three honorees.

As a musician, I recall the song, "A Charge to Keep I Have." We have a charge to keep for we must practice generativity to inspire more African Americans to persist in the pipeline and to accomplish similar accolades. I invite you to join me in honoring Dr. Innis, Dr. Weems, and Dr. Scott. There are words of wisdom that say, "To whom much is given, much is required." The honorees have been given much. Therefore, much is required of them and all of us who have benefited from Erikson's concept, generativity. We must exercise "a concern for establishing and guiding the next generation" of mathematicians. Our efforts can be optimized by our participation in conferences and events developed, sponsored, and implemented by the National Association of Mathematicians.

Jacqueline Brannon-Giles *is a lifetime member of NAM and previously served on the board of NAM. She can be reached at* `jbgiles@yahoo.com`. □

UM Student Services Center Renamed to Honor Donald Cole

Staff Reporter, Ole Miss

This is a reprint of the Ole Miss Media Release published on the University of Mississippi website on October 19, 2020 https://news.olemiss.edu/student-services-center-renamed-to-honor-donald-cole/

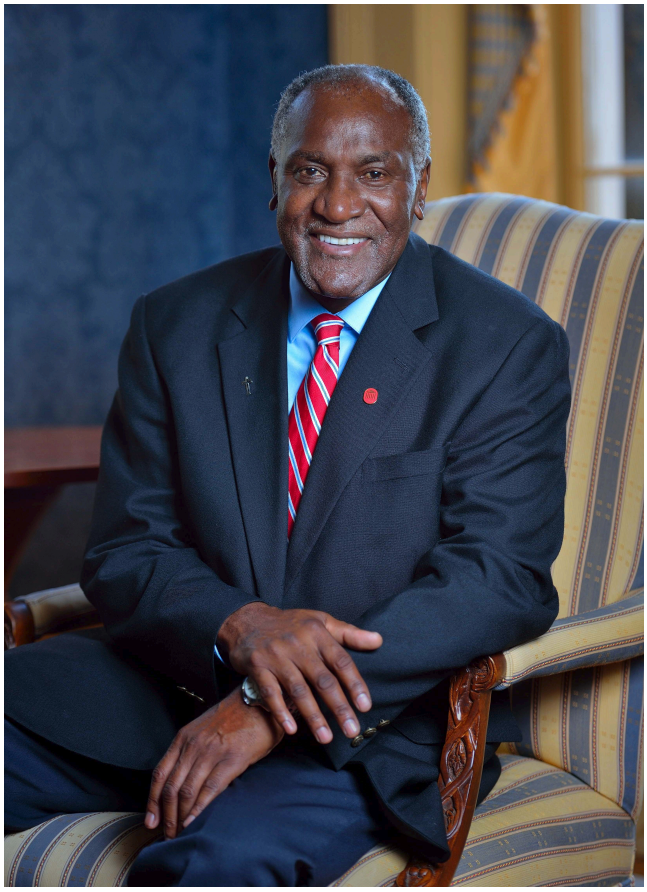
OXFORD, Miss. – The University of Mississippi will rename a major campus building in honor of Donald R. Cole, a former student activist who returned to Ole Miss as a caring mentor and administrator for decades.

The Mississippi Institutions of Higher Learning board voted unanimously Thursday (Oct. 15) to rename the Martindale Student Services Center as the Martindale-Cole Student Services Center. The change was requested by Larry Martindale, former Ole Miss basketball player and longtime university supporter.

Cole retired in January after a storied career as a student, professor and administrator known for being a tenacious advocate for diversity and working tirelessly to encourage students of all backgrounds to find and pursue their passions at the university.

His longstanding contributions to student success at UM make Cole a clear and worthy namesake of a building dedicated to that mission, Chancellor Glenn F. Boyce said.

"Dr. Cole's legacy can be seen, heard and felt all across this institution each and every day, so it's very fitting that his name adorn the very building that so many students go to for support on our campus" Boyce said.



Donald Cole, who retired in 2019 after more than 50 years at the University of Mississippi as a student, educator and administrator, has been honored by having his name added to the university's Student Services Center. Cole, known for being a tenacious advocate for diversity and opportunity for all students, said he is speechless and humbled at having the building renamed the Martindale-Cole Student Services Center. Photo by Robert Jordan/Ole Miss Digital Imaging Services

"He embodies the care and embrace that many of our university family strive for in order to truly help each student reach their full potential during their time at Ole Miss.

"We're so pleased that students, for generations to come, will continue having Dr. Cole at their side."

The university's resolution reads, "Believing that education is the 'great equalizer' and the central feature in the prevailing endurance of mankind, Dr. Cole is a stern advocate for education, particularly for minority students. He devotes his time and energy to projects and causes that promotes the schooling, teaching, training and guidance opportunities of our children – particularly toward advanced degrees. Dr. Cole dedicated his life to portraying UM as a 21st-centry institution and he is a stern advocate for the institution."

A celebratory campus event to commemorate the renaming will be scheduled later.

Cole described the honor as "a surreal phenomenon" and said he wants to thank the Martindales and everyone who made it possible.

"Why me?" Cole said. "I'm speechless. Now I know what it means to have love returned. You didn't have to, but you did. Although my thoughts about the matter will evolve over time, much of it will remain constant: I'm humbled, I'm appreciative, I can't believe it. Hallelujah!

"When my feelings settle, I'm sure that I will have added much more to that list and to the divine providence that connected the university, myself and so many other wonderful people to make this naming possible. I'm grateful."

The building opened in 1929 and for many years was where the university's basketball teams, including Martindale, competed. Martindale gave the lead gift for its renovation in 1995. The Martindales have two children: son Bryan Martindale, who married Virginia Naryka – both Ole Miss graduates – and daughter Lauren, married to Mike Suhrbier. The Martindales have three grandchildren.

On one of his recent campus visits, Martindale was sitting inside the building reading the Daily Mississippian. He noticed a group of prospective students and their parents had gathered to go on a campus tour, and he decided to tag along.

"The student giving the tour did a fabulous job of talking about the campus and ended up spending about 10 minutes explaining the James Meredith statue," Martindale said. "It just hit me that it would be nice if the building named for us could represent the diversity I saw in the students gathered for the tour.

"Susan and I had been talking about how to add even more meaning to the building."

He met with the administration about his idea, which was enthusiastically received. He asked for suggestions for some-

one to honor by the naming opportunity. He and his wife were provided a list of possible honorees, and they immediately were drawn to Cole.

They have since gotten to know Cole well and are pleased to share the recognition with the longtime university leader.

"This is about all of us coming together," Martindale said. "The building should represent who we are today and that this university is moving forward. Susan and I want to help with race relations on campus and also in Mississippi."

Boyce expressed his gratitude to the Martindales for their continued leadership and support of the university over the years.

"We're tremendously grateful for the many ways that Larry and Susan Martindale have supported the university and how they continue to engage as members of the Ole Miss family on important issues of campus life that help move our university forward," he said.

The university's request to the IHL notes Cole's 50-year affiliation with Ole Miss and how the beloved educator is a natural fit for such an honor.

The Jackson native entered UM as a freshman in 1968. Not finding the university welcoming for students of color, he wanted to fix the situation. As a member of the Black Student Union, he presented administrators with a list of demands, asking for an end to overt racism, more opportunities for black students and staff, and the hiring of black faculty.

In 1970, he protested at a campus concert, was arrested and spent two nights in jail. He and seven other students were expelled.

It would have been easy not to return to the university, but Cole had unfinished business. That's his best answer as to why he came back, anyway.

"I had not truly failed at anything, and I had come here to get a degree and I had failed to get a degree," Cole said in an interview earlier this year. "I had left in disgrace, left with a jail certificate, and I had come here, not by myself, but come here representing so many others, and I suspect that I had feelings about letting so many other folks down, and maybe this gave me another shot at redeeming myself, and that's the nearest that I can answer."

Besides his roles as program director, grant writer, mentor and mathematics professor, Cole also served as a university administrator. Under Chancellor Emeritus Robert Khayat, he was named assistant to the chancellor for multicultural affairs.

He chaired the Chancellor's Standing Committee on Sensitivity and Respect until last year; co-chaired the Extended Sensitivity and Respect Committee in 2013, which was initiated after an election night

incident in 2012; and co-chaired the Chancellor's Advisory Committee on History and Context the last couple of years.

He's found a home in Oxford. He and his wife, Marcia, have been married for more than 40 years, and have three children: Donald II, Mariah and William. He's also a deacon and trustee of New Hope M.B. Church in Oxford.

The university and its students have benefitted from his quest to handle unfinished business that led to a 25-year career of teaching, research and service. When Cole retired, James Reid, chair and professor of mathematics, uncovered an eye-popping stat that speaks to Cole's dedication for helping students.

"It was noted in that June/July 2009 issue of the Notices of the American Mathematical Society that over one-third of the African Americans who received Ph.D.s nationally that year had graduated from this university in 2006," Reid said.

"Dr. Cole was an essential contributor to this effort and recruited and mentored many of these students. He is a remarkable member of the Ole Miss family."

Ole Miss *The University of Mississippi, affectionately known as Ole Miss, is the state's flagship university. Ole Miss has a long history of producing leaders in public service, academics and business. To contact the staff writer at Ole Miss email Rod Guajardo at* `rod@olemiss.edu`. □

Book Review: Asked and Answered: Dialogues on Advocating For Students of Color in Mathematics

Zakiya Jones, Dr. Vanessa Rivera Quiñones, and Dr. Dwight Anderson Williams II

From the hosts of the podcast *Mathematically Uncensored*, Dr. Pamela E. Harris and Dr. Aris Winger, we present *Asked and Answered: Dialogues on Advocating For Students of Color in Mathematics*. This book is inspired by the authors' work on creating and leading professional development programs that bring together mathematics/math education faculty and K-12 STEM educators throughout the United States.

Through their five dialogues, Drs. Harris and Winger provide you a window into the process of going from bystander to advocate for students of color in mathematics. Readers are challenged to reflect on their advocacy journey through action that centers students of color in mathematics and their experiences.

If you care about marginalized students in math and want to do something to improve the math community, after reading Asked and Answered there is no excuse not to. This book is a starting place for you to make an impact, for you to reflect on your history, and for you to assess your priorities, biases, and misconceptions. It is the check-in that anyone who is doing the work of advocating for students of color in math needs in order to reflect on and reevaluate their approach to make sure it is centering students' experience and wellbeing. It answers important questions many people ask themselves when they decide they want to fight to create more supportive environments for marginalized students in math.

This book provides a clear and actionable path for educators at all stages of their careers to support students of color sustainably. It asks you to be uncomfortable, to take inventory of the tools at your disposal, to acknowledge where you have failed and succeeded, and where there is room to grow. This is a life-long and life-changing journey. By committing yourself to be an agent of change, you will join the Advocating For Students of Color in Mathematics community in embarking on its mission to uproot the culture of mathematics.

Now Asked and Answered does not promise to be a quick-fix theorem. Rather, a consistent tone rings throughout that you must relentlessly dismantle conditions valuing mathematics over people. These pages confront the extraordinary power of your choices or inaction in transforming the lives of your students. And it is only through acknowledgment and intentional

disruption of comfort that you'll understand, "Your voice and actions have a deep impact and we believe that working together to advocate for students of color will create a culture shift which will allow students of color to thrive fully and authentically as themselves within the mathematical sciences." – Preface, Asked and Answered: Dialogues on Advocating For Students of Color in Mathematics.

Vanessa Rivera Quiñones, *is a mathematical biologist with a passion for telling stories through numbers using mathematical models, data science, science communication, and education. She can be contacted at* `vriveraq.phd@gmail.com`. □

The Roles of SIR Mathematical Models in Epidemiology

Talitha Washington and Ronald Mickens

This is a reprint of the American Physical Society, Forum on the History of Physics 2020 Fall Newsletter https://engage.aps.org/fhp/resources/newsletters/fall-2020

Abstract: Many human based diseases are analyzed using so-called SIR mathematical models. Our major goals are to examine the structure of these models, discuss what useful information can be derived from them, and indicate how they may be used to make general predictions on the possible courses of the associated diseases when particular types of actions are taken. We conclude that the simplest SIR models are valuable as tools for deriving critical qualitative features of the spread of disease. Various issues are also considered relative to the successes and failings of these models.

1. Introduction

Currently, October 2020, the world is engaged in a pandemic caused by "severe acute respiratory syndrome coronavirus-2", better known as ARS-CoV-2 [2]. This not previously seen disease in humans can spread easily from person to person. It is estimated that the median time from onset to clinical recovery for mild cases is approximately two weeks and is on the range of 3 to 6 weeks for patients with severe or critical disease [3]. A major non-laboratory tool used to analyze, understand, and predict the course of this disease in humans is mathematical modeling [4]. The most basic of such models is the SIR model where the total population is assumed to be constant is divided into three sub-populations:

- $S(t)$ – susceptible and individuals who are uninfected;
- $I(t)$ – infected individuals who upon contact with susceptible individuals can infect the susceptible;
- $R(t)$ – recovered and/or removed individuals who have either recovered from their infection or have removed themselves by dying, etc.

The task of such models is to predict the trajectory of the epidemic as transitions are made from one population class to another, i.e.,

$$S(t) \longrightarrow I(t) \longrightarrow R(t). \tag{1}$$

SIR models are explicitly constructed to provide this information or estimates of it. These results are important since "there is a critical need to understand both the likely number of infections and their time course to inform both public health and health care system responses" [5].

Mathematical modeling is important because we wish to both understand and manipulate the uni-

verse, so that predictions can be made of its future states or conditions. Mathematical modeling allows for a partial resolution of this goal. However, different models may, in general, only allow the probing of different aspects of our original system. Thus, it should be kept in mind that the models are not the actual system. They are abstract mathematical representations of some of its features, the ones (hopefully) of relevance for our needs.

Talitha Washington and Ronald Mickens
(Photo by Talitha Washington)

The purposes of this paper are several:

(1) Show the construction of a SIR model where the total population is assumed to be constant. This model consists of three coupled ordinary differential equations and is perhaps the simplest of possible SIR models.

(2) Provide appropriate interpretations of the parameters appearing in the equations and their connection to epidemiology data.

(3) Derive, using elementary mathematics, a number of the significant aspects or features of the solutions.

(4) Give a direct geometrical explanation of the effects of "stay-at-home-orders" and their relaxation.

(5) Provide "an abundance of evidence," as a consequence of the above results, that a simple SIR differential equation mathematical model allows detailed predictions to be made for all the major qualitative feature for he spread of a disease such as COVID-19.

This paper is organized as follows: In the next section, we present the general methodology for the construction of a SIR mathematical model with the total population constant. Section 3 presents on explicit SIR model and show how it may be used to calculate quantities such as the conditions necessary for an epidemic to occur, the general time dependent behaviors expected for $S(t)$, $I(t)$ and $R(t)$, and the number of total persons infected. Section 4 gives a geometrical argument to show the consequences of stay-at-home orders. In Section 5, a SIR model, satisfying all the conditions given in Section 2 is presented and discussed briefly. An important aspect of this model is that an exact, explicit solution to it can be calculated. Finally, we summarize our general results in Section 6 and briefly indicate how the simple SIR model can be generalized to include an exposed, but not infectious population class, how to include vaccination, and how to model vaccination with limited immunity.

2. Methodology of SIR Models

The most elementary SIR models are based on certain (simplistic) assumptions [6, 7]:

(i) The total population is composed of only three sub-populations, i.e., susceptibles, $S(t)$; infected, $I(t)$; and recovered, $R(t)$. Susceptibles are uninfected and susceptible to the disease; the infected population is, by definition, infected and they can in turn infect susceptibles; and recovered individuals have recovered from the disease and are now immune to reinfection.

(ii) The total population is taken to be constant, i.e.,

$$S(t) + I(t) + R(T) = N = \text{ constant}. \quad (2)$$

This constraint means that over the time interval for which the model is relevant, the birth and death rates are equal.

(iii) It is assumed that there is homogeneous mixing of the three populations. This means that all individuals in the total population have exactly the same probability of coming into contact with each other and interacting [5].

Further, it is assumed that the disease can be transmitted between any two individuals regardless of their location and age.

The explicit construction of a SIR model begins when a framework is formulated for determining how the three populations transfer from one population to another; see Eq. 1. For our purposes, we use the scheme

$$\frac{\Delta S}{\Delta t} = -T_1(S \to I), \tag{3}$$

$$\frac{\Delta I}{\Delta t} = T_1(S \to I) - T_2(I \to R), \tag{4}$$

$$\frac{\Delta R}{\Delta t} = T_2(I \to R), \tag{5}$$

where

$$\Delta V \equiv V(t_2) - V(t_1), \quad \Delta t = t_2 - t_1, \tag{6}$$

and

$T_1(S \to I) =$ transition rate from the S population to the I pop'n,

$T_2(I \to R) =$ transition rate from the I population to the R pop'n.

Note that adding Eqs. 3 through 5 gives

$$\frac{\Delta}{\Delta t}\left[S(t) + I(t) + R(t)\right] = 0, \tag{7}$$

which is equivalent to the result expressed in Eq. 2. Also, observe the placement of the negative signs in Eqs. 4 and 5. This convention allows us to define the transition functions to be non-negative, i.e.,

$$\begin{cases} T_1(S \to I) > 0, \ T_2(I \to R) > 0, \\ S > 0, \ I > 0. \end{cases} \tag{8}$$

So what about the mathematical structure of $T_1(S \to I)$ and $T_2(I \to R)$? To be definitive in what follows, we will only examine deterministic, ordinary differential equation models and doing this gives for Eqs. 3 to 5 the three coupled equations

$$\frac{dS}{dt} = -T_1(S \to I), \tag{9}$$

$$\frac{dI}{dt} = T_1(S \to I) - T_2(I \to R), \tag{10}$$

$$\frac{dR}{dt} = T_2(I \to R). \tag{11}$$

This particular structure is easy to understand. First, take the transition rate functions, T_1 and T_2, to be non-negative. It follows that there must be a negative sign on the right-side of Eq. 9 since each S that gets infected gets transferred into the I-population. Thus, the S-population decreases and the I-population increases. Similarly, the first term on the right-side of Eq. 10 corresponds to additions to the I-population coming from newly infected members of the S-population. The second term on the right-side of Eq. 10 represents those members of the I-population that have recovered from the disease and now get transferred to the R-population.

A deep, careful consideration of the general dynamics of the systems to be modeled by an SIR representation allows us to conclude that the simplest transition functions must have the following mathematical properties:

$\mathbf{T_1(S \to I) \equiv T_1(S, I)}$

(a) $T_1(S, I) > 0$, for $S > 0$, $I > 0$;

(b) $T_1(0, I) = T_1(S, 0) = 0$;

(c) $T_1(S, I)$ is a monotonic increasing function of S and I.

$\mathbf{T_2(I \to R) \equiv T_2(I)}$

(a) $T_2(I) > 0$, for $I > 0$;

(b) $T_2(0) = 0$;

(c) $T_2(I)$ is a monotonic increasing function of I.

$T_1(S_1, I)$ and $T_2(I)$ indicate that the respective transition amplitudes are functions of S and I, and I. There are many possible selections of functions $T_1(S, I)$ and $T_2(I)$ which satisfy these restrictions. The papers of Korobeinikov and Maini [9], and Hethcote and Driessche [8] provide some choices.

3. Standard SIR Model

The standard, most used, SIR model is constructed using the following choices for the transition functions [6, 7]

$$T_1(S,I) = \beta S\left(\frac{I}{N}\right), \quad T_2(I) = \gamma I, \tag{12}$$

or

$$\frac{dS}{dt} = -\beta S\left(\frac{I}{N}\right), \tag{13}$$

$$\frac{dI}{dt} = \beta S\left(\frac{I}{N}\right) - \gamma I, \tag{14}$$

$$\frac{dR}{dt} = \gamma I. \tag{15}$$

The β and γ are constant parameters and are usually interpreted as being related to important aspects of the progression of the disease as seen in the following argument.

The left-hand sides of Eqs. 13 to 15 have the physical units of populations number over unit time. Therefore, all the right-hand side terms must also have these physical units. Examination of $T_1(S,I)$ and $T_2(I)$ allows the conclusion that the two parameters, β and γ, have the physical unit of inverse time. From this result, they are then given the interpretations

$t_c = \frac{1}{\beta} =$ average time between contacts of the S and I populations,

$t_r = \frac{1}{\gamma} =$ average time a member of the infected population stays infected and then gets transferred to the removed population.

It is important to observe that Eqs. 13 and 14 do not involve R. A major consequence of this fact is that in the analysis of this SIR system of equations only Eqs. 13 and 14 need to be considered since R can be determined from Eq. 2, i.e., $R = N - S - I$.

Note that the equation for dI/dt can be algebraically manipulated into the following expression

$$\frac{dI}{dt} = \beta\left(\frac{I}{N}\right)(S - S^*), \tag{16}$$

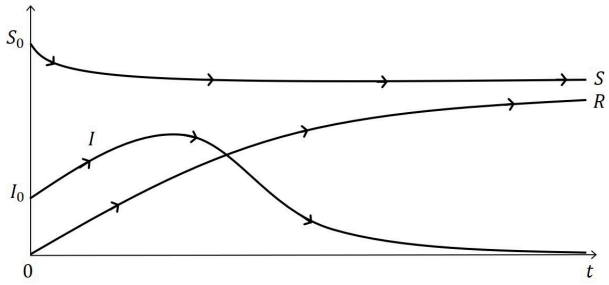
where

$$S^* = \frac{\gamma N}{\beta} = \left(\frac{t_c}{t_r}\right) N = \text{constant}. \tag{17}$$

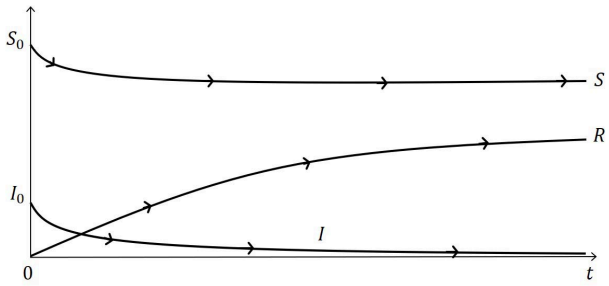
Keep in mind the fact that $dI/dt > 0$ implies that $I(t)$ is increasing, while $dI/dt < 0$ means that $I(t)$ is decreasing. Also, both $S(t)$ and $I(t)$ are always non-negative. With this information, the following conclusions can be immediately drawn from an examination of Eq. 16:

(i) Let at time $t = 0$, $S(0) = S_0 > 0$ and $I(0) = I_0 > 0$, with $I_0 \ll S_0$. If $S_0 > S^*$, then $I(t)$, for $t > 0$, initially will increase. But from Eq. 13, $S(t)$ will decrease. At some future time, $S(t)$ will fall below S^* and $I(t)$ will begin to fall. This situation is depicted in Figure 1(a). For this case, we have a classical epidemic.

(ii) For the same initial conditions as in (i), but with $S(0) < S^*$, $I(t)$ decreases to zero; see Figure 1(b). No epidemic takes place.



(a) $S_0 > S^*$



(b) $S_0 < S^*$

Figure 1: General time dependence of $S(t)$, $I(t)$, and $R(t)$ for (a) an epidemic $S_0 < S^*$, $r_0 > 1$) and (b) no epidemic ($S_0 < S^*, r_0 < 1$).

Thus, we are led to the famous threshold theorem of epidemiology [4, 6, 7]. The placement of a single infective in a susceptible population will only initiate an epidemic if the number of susceptibles in larger than a certain threshold value, in our case it is S^*. Another way of stating this result is to note that

this is equivalent to the condition that the rate at which susceptibles become infectives must be larger than the rate at which infectives are eliminated from the population; see Eq. 16.

An alternative way to proceed is to introduce r_0, the so-called "basic reproduction number" [5, 6]. We define r_0 as

$$r_0 \equiv \left(\frac{\beta}{\gamma}\right)\left(\frac{S_0}{N}\right) = \frac{S_0}{S^*}. \tag{18}$$

The parameter r_0 plays a fundamental role in SIR based epidemiology and is generally interpreted as the average number of secondary infections caused by the introduction of a single infective individual into a susceptible population. It is easily seen that if $r_0 > 1$, then an epidemic will occur, while for $0 < r_0 < 1$, the infective population decreases from the start and no epidemic takes place.

The curve of I versus S provides further insights into the dynamics of the SIR model. It can be shown (with just a knowledge of first-year calculus) that the slope of the $I(s)$ versus S curve is given by the expression [6, 7]

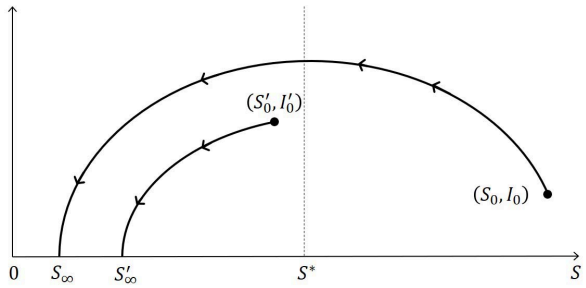
$$\frac{dI}{dS} = -1 + \frac{S^*}{S}, \tag{19}$$

and this equation can be integrated to give the result

$$I + S = I_0 + S_0 + S^* \ln\left(\frac{S}{S_0}\right), \tag{20}$$

where $S = S(t)$, $I = I(t)$ and $S_0 = S(0)$, $I_0 = I(0)$, and $R(0) = R_0 = 0$.

Figure 2 gives a plot of the I versus S curve for two situations: (i) $S_0 > S^*$, leading to an epidemic; and (ii) $S_0 < S^*$, for which no epidemic occurs. These two cases correspond, respectively, to whether $r_0 > 1$ or $r_0 < 1$. Note that in terms of time behaviour, the motion along these curves goes from the right to the left sides of the graph and exactly correspond to the plots presented in Figure 1.



Plots of I versus S. The upper curve depicts an epidemic ($S_0 > S^*$), while the lower curve ($S_0^* < S^*$) does not lead to an epidemic.

For the remainder of this section, only the case of an epidemic will be considered. Of interest is a determination of $I_{\max}$, S_∞, and I_{total} where

$I_{\max}$ = the maximum value of the number of infectives during the course of the epidemic;

S_∞ = the number of susceptibles who do not succumb to the epidemic;

I_{total} = the total number of susceptibles who become infected.

Using Eq. 20, it follows that these quantities are given by the expressions

$$I_{\max} = I_0 + (S_0 - S^*) + S^* \ln\left(\frac{S^*}{S_0}\right), \tag{21}$$

$$S_\infty = S_0 + I_0 + S^* \ln\left(\frac{S_\infty}{S_0}\right), \tag{22}$$

$$I_{\text{total}} = (S_0 - S_\infty) + I_0. \tag{23}$$

Note that we are "given" the parameters β and γ, and the total population N, and this allows S^* to be calculated, see Eq. 17. In addition, the initial numbers of the infectives and susceptibles, i.e., I_0 and S_0, are also specified. Thus, $I_{\max}$, S_∞, and I_{total} may be determined, respectively, from Eqs. 21, 22, and 23.

Comment: The equation to be solved for S_∞, given in Eq. 22, allows for it to be expressed in terms of a "new elementary function." the so-called Lambert-W function [10].

In summary, given the elementary SIR model where the parameters β and γ are known, given the

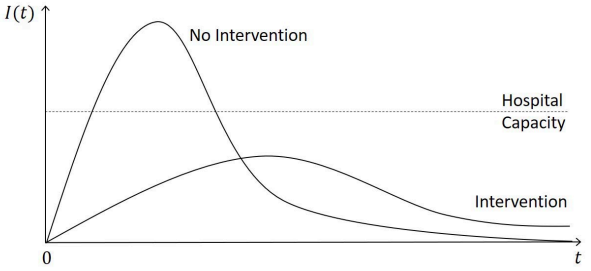
size of the total population, $N = S_0 + I_0$, it follows that all of the general qualitative features can be determined, and values for $I_{\max}$, S_∞, and I_{total} can be calculated. This realization is important since for this model explicit, exact, close-form solutions do not exist for $S(t)$ and $I(t)$, expressible in terms of a finite combination of the elementary functions.

4. Flattening the Curve

The curve that is being talked about is the plot of $I(t)$ versus t, i.e., the number of infectives as a function of time, t.

Hospitals generally have a maximum capacity for treating acute illnesses in terms of the number of beds and available care teams. Further, some hospitals and emergency facilitates may already be operating close to their maximum capacity under normal circumstances.

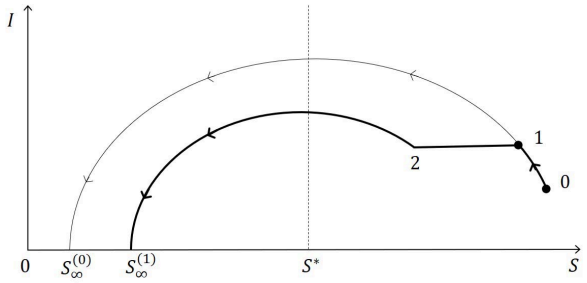
If the sharply peaked curve (see Figure 3) could be changed into a broader, flatter, lower curve, lying below the capacity curve of the hospital, then this would help hospitals provide better care for their patients and allow some relief to their emergency care staff. Figure 3 illustrates this situation [11].



Flattening the curve: plot of $I(t)$ versus t for no intervention and for the outcome of good interventions.

Note that what we wish to achieve is a lowering of the total number of cases who are in the hospital at any given time to a number smaller than the maximum capacity and spread them out over a longer period of time [11]. This lowering and spreading can be achieved, in the absence of an actual effective vaccine through the use of physical distancing, stay-at-home orders, the appropriate wearing of face masks and a number of other measures. All of these actions may be characterized as non-pharmaceutical interventions [12].

We now study the consequences of a non-pharmaceutical intervention on the outcomes of the simple SIR model. This can be done without any new mathematical effort. The purpose of the intervention is to "flatten the curve" and for ease of interpretation and explanation, we consider a stay-at-home order. In the immediate discussion, all of our comments and observations will refer to the curves in Fig 4.



Consequences of the initiation of a stay-at-home order (beginning at 1; follow the heavy lines).

The initiation of the epidemic is at point 0, where $P_0 = (S_0, I_0)$. The system then evolves to point $P_1 = (S_1, I_1)$ where

$$S_1 < S_0, \quad I_1 > I_0. \tag{24}$$

At P_1, the stay-at-home order is made and we assume that some fraction of the susceptible population obeys this edict. (The exact value is not important; it just needs to remain constant for the arguments to be valid.) The system now goes from P_1 to $P_2 = (S_2, I_1)$, i.e., S changes (decreases) from S_1 to S_2, with $S_2 < S_1$, but the number of infectives remains constant at the value I_1.

At P_2, the SIR system evolves in the usual manner, with $S(t)$ steadily decreasing to the value $S_\infty^{(1)}$, and $I(t)$, at first increasing to a peak and then decreasing to zero.

A close inspection of Figure **??**, allows the following conclusions to be made:

(i) The evolution of the system with the stay-at-home order gives a smaller value for the peak number of infectives as compared with having no such order.

(ii) Because $S_\infty^{(1)} > S_\infty^{(0)}$, the total number of infections during the epidemic is reduced with a stay-at-home order.

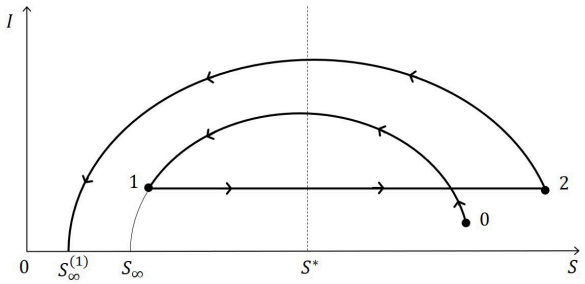
(iii) Since the graphs in Figure 4 do not contain temporal information, we cannot directly show the peak in infectives occurs later for the situation where a stay-at-home order is in place. However, this does turn out to occur [13].

The graphs in Figure 5 illustrate what can happen when a stay-at-home order is released. Assume that the path connecting point 0 (P_0) and point 1 (P_1) corresponds to a stay-at-home situation. Let the order be released at $P_1 = (S_1, I_1)$. The system now goes to $P_2 = (S_2, I_1)$ and continues along the upper curve. Examining this graph gives the following results:

(a) The second peak in the infective curve is now larger after the stay-at-home order is dropped.

(b) After the epidemic has reached its course, the total infective population is also larger.

(c) In summary, a stay-at-home order, followed by letting the SIR system evolve and then releasing the order may lead to a situation where the second peak and spread of the disease increases. This is due mainly to the sudden infusion of new susceptibles into the population and they can now potentially be infected.



One possibility of halting a stay-at-home order (beginning at 1).

5. Model with Exact Analytical Solution

It turns out that an SIR model can be constructed satisfying all the requirements in the Methodology of SIR Models Section, such that its explicit solutions may be calculated in terms of a finite combination of the elementary functions, namely, the trigonometric functions [14]. For our purposes, this model takes the form

$$\frac{dS}{dt} = -\beta\sqrt{S}\sqrt{I}, \quad \frac{dI}{dt} = \beta\sqrt{S}\sqrt{I} - \gamma\sqrt{I}, \quad (25)$$

$$\frac{dR}{dt} = \gamma\sqrt{I}, \quad (26)$$

$$S(0) = S_0 > 0,\ I(0) = I_0 > 0,\ R(0) = 0 \quad (27)$$

Note that the total population is constant, i.e.,

$$S(t) + I(t) + R(t) = N = \text{ constant }, \quad (28)$$

and further, only the differential equation involving $S(t)$ and $I(t)$ need be investigated.

The transformation

$$u(t) = \sqrt{S(t)}, \quad v(t) = \sqrt{I(t)}, \quad (29)$$

gives

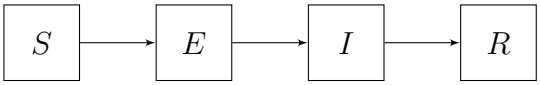
$$\frac{du}{dt} = -\left(\frac{\beta}{2}\right)v, \quad \frac{dv}{dt} = \left(\frac{\beta}{2}\right)u - \left(\frac{\gamma}{2}\right), \quad (30)$$

a pair of linear, coupled equations which may be easily solved [14]. This model does have the interesting feature that $I(t)$ goes extinct in a finite time. See Mickens [14] for the full details.

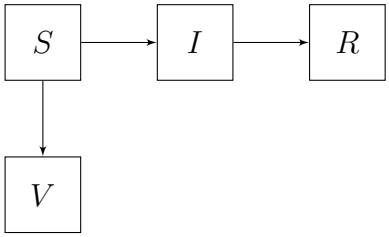
6. Discussion

An important feature of our investigation of the elementary SIR model is that no explicit knowledge of the solutions for $S(t)$ and $I(t)$ are needed to either analyze or understand the essential details of the evolution of these solutions. This means that all of the basic qualitative properties can be determined without the use of advanced mathematical techniques. Further, instances where exact solutions do exist, by means of a proper selection of $T_1(S, T)$ and $T_2(I)$, these solutions are in full agreement with the expectations obtained from the qualitative investigations. Consequently, we may expect that our modeling process can be applied to actual epidemics even if we only wish to know the various aspects of their major qualitative features as they evolve. Thus, in spite of the fact that we only have incomplete knowledge, there is enough value obtained from the use of these qualitative techniques to help policy makers make certain general but valid decisions to limit disease spread.

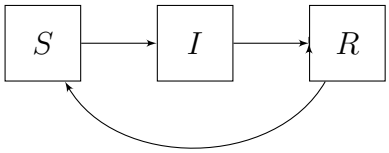
Also, it is critical to understand that simple SIR models can be readily generalized to include other components such as adding an exposed class (infected, but not infectious individuals)



the inclusion of vaccination



and putting in limited immunity



As a further complexity, these features can be combined in a mega-model, with time-dependent parameters [4, 6, 7, 12]. Finally, it should be observed that the modeling of the evolution of a disease is not dependent on a mathematical representation by a set of coupled, ordinary differential equations. There are many mathematical structures available for use: continuous versus discrete time, deterministic versus stochastic, qualitative versus quantitative methods, etc. Generally, the particular mathematical structure selected is the choice of the modeler(s). What this article indicates is that even elementary mathematical models can be used to provide important insights into how to limit the spread of disease.

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[1] [Editor's Note: This is an invited contribution, serving as an introduction to epidemic mathematical modeling, by two experts – APS Fellow Ronald Mickens and AMS Fellow Talitha Washington.]

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Member Feature: Dr. Cory Colbert

by Omayra Ortega & Cory Colbert

The NAM Newsletter had the pleasure of interviewing Dr. Cory Colbert, Assistant Professor of Mathematics at Washington & Lee University in Lexington, VA and Treasurer to the National Association of Mathematicians (NAM). https://my.wlu.edu/directory/profile?ID=x23408

Q: How did you first hear about NAM and become a member of this organization?

I heard about NAM through former NAM President and Professor of Mathematics at Pomona College Dr. Edray Goins. After learning a lot of about NAM, I decided that I wanted to become a member of NAM and join the effort in promoting the research and excellence of underrepresented minorities and mathematicians of the African Diaspora in particular.

Q: Do you do any service for NAM or other professional associations?

Yes. I currently serve as NAM's treasurer. I took office on February 1, 2020. I also work for Bridge to Enter Advanced Mathematics (BEAM) during the summers, where I teach college-level classes to high-potential and very bright middle-schoolers.

Q: What inspired you to work in your field of expertise?

I've always had an affinity for prime numbers, prime ideals, rings, and algebra in general. I guess it felt natural to pursue it, even though I find the material pretty difficult.

Q: What is your most favorite aspect of your field of expertise?

In a weird way, I'm attracted to the abstraction of it all. It can be dry at times, but it is fun to work in an entirely abstract theory with few tangible, easy examples and try to make sense of everything.

Q: Do you have any recent publications or projects that you are excited about?

Yes, several! I have several projects that I'm working on right now that are really fun. I have two projects with collaborators, one of which is in geometry and manifold theory, a new direction for me, and the other of which is in the theory of complete local rings, a much more familiar topic. I

also have a solo project that is wrapping up. It involves searching for and proving various types of invariants for certain infinite, partially ordered sets.

Q: Who or what inspired you to pursue academia?

It's just always been the right fit. I'm a natural teacher – I love being in front of the classroom teaching and learning with my students. I also really love the laid-back environment and flexibility that comes with academia, with very generous amounts of time away from campus to focus on my research, develop my teaching, and pursue other academic interests and hobbies.

Q: Do you want to give a shot out to any special mentors, supporters, or muses that helped you in your career?

Absolutely. I'd have to give a huge thanks to Dr. Kevin Beanland, a personal friend, mentor and now colleague who has been with me every step of the way. When I was an undergraduate at Virginia Commonwealth University, he was both my professor and one of my biggest and most important advocates. He encouraged me to participate in summer math programs and REUs, and he encouraged me to go to graduate school. We kept in contact over all those years, and now we are both faculty in the same math department! I also want to give a special shout-out to Dr. Edray Goins of Pomona College who was (and still is!) a crucial mentor for me during those difficult graduate school and post-graduate school years.

Q: Were there any barriers to your success along the way?

Like many of my peers, I definitely suffered from the well-known "impostor syndrome." I've also had to deal with the numerous microaggressions that Black people in academia and graduate studies face on a daily basis. However, I have a certain tenacity and will to keep fighting for what I want no matter how turbulent or difficult things may be.

Q: What would you tell students interested in pursuing an academic career?

You can do it! It will not be easy, but I can promise that after all the exams, courses, qualifiers, defenses, and job-hunting, you'll reach a moment where you look back and realize that it was worth it. In academia, you'll not only be able to teach and be an expert scholar in your chosen field, but you'll also be able to mentor others and be that impactful individual that helped you get to where you are.

Q: Any advice on how to persist and excel during this unprecedented time of shelter-in-place and remote learning?

What's worked for me is the establishment of a daily routine and a well-defined workspace away from distractions. I commit to waking up at a decent hour, making breakfast and coffee, and working until a certain time.

Omayra Ortega *is an Assistant Professor of Mathematics & Statistics at Sonoma State University. She can be reached at* `editor@nam-math.org`. □

national math festival

FREE, ALL AGES ONLINE EVENT

Register on Eventbrite

NMF Live Online Weekend: April 16-18

FEATURED MATHEMATICIANS

Dr. Robbert Dijkgraaf (Institute for Advanced Study)
The End of Space and Time: The Mathematics of Black Holes and the Big Bang

Dr. Erica Graham (Bryn Mawr College), **Dr. Raegan Higgins** (Texas Tech University), **Dr. Candice Price** (Smith College), and **Dr. Shelby Wilson** (Johns Hopkins University)
Changing the 'Face' of Mathematics

Dr. Emille Davie Lawrence (University of San Francisco)
Math Is Play!

Dr. Jesús De Loera (University of California, Davis)
Numbers through Pictures: A Taste of the Geometry of Numbers

Dr. Steven Strogatz (Cornell University)
Infinite Powers: The Story of Calculus

Dr. Joseph Teran (University of California, Los Angeles)
Math and the Movies

Film Screenings & Discussion Panels

Hands-On Activities at Interactive Booths & Sessions

Join some of the world's savviest math organizations for a tour-de-force of online fun! Come prepared to learn, engage, laugh, grow, play, and be part of an exciting math community for kids and adults of all ages. All events are free of charge and held on **Hopin.com**.

Join Our Free Online Communities

Math Moms and Math Dads Facebook Group

facebook.com/groups/mathmomsandmathdads

NMF Weekly Math Puzzle Newsletter with Dr. James Tanton

globalmathproject.org/nmf-weekly/

nationalmathfestival.org

MSRI Mathematical Sciences Research Institute

IAS INSTITUTE FOR ADVANCED STUDY

MOMATH NATIONAL MUSEUM OF MATHEMATICS

The overarching goal of the **MSRI Workshop on Mathematics and Racial Justice** is to explore the role that mathematics plays in today's movement for racial justice. For the purposes of this workshop, racial justice is the result of intentional, active and sustained anti-racist practices that identify and dismantle racist structures and policies that operate to oppress, disenfranchise, harm, and devalue Black people. This workshop will bring together mathematicians, statisticians, computer scientists, and STEM educators as well as members of the general public interested in using the tools of these disciplines to critically examine and eradicate racial disparities in society. Researchers with expertise or interest in problems at the intersection of mathematics, statistics and racial justice are encouraged to participate. This 6-day workshop will take place over two weeks in June and will include sessions on Bias in Algorithms and Technology; Fair Division, Allocation, and Representation; Public Health Disparities; and Racial Inequities in Mathematics Education.

Events of Interest to NAM Members

A complete list of events containing these and more can be found online:

https://www.nam-math.org/upcoming-activities.html

The Graduate Online Combinatorics Colloquium (GOCC) is a student-run weekly online combinatorics seminar intended for graduate students of all levels and areas of combinatorics. Our goal is to support early-career mathematicians and provide a low-pressure seminar consisting of both research and expository talks. For information, see the following link. If you'd like to join the listhost and/or volunteer to give a talk, please email gocccombinatiorics@gmail.com.

Julia Robinson Mathematics Festival

The Julia Robinson Mathematics Festival (JRMF) seeks to inspire joy in mathematics through exploration and collaboration. Due to COVID-19, the JRMF team has been organizing Zoom Webinars in 3 different languages: English (Saturdays at 7 pm EDT), Spanish (Saturdays at 12 pm EDT) and Hebrew (Thursdays at 12 pm EDT). These virtual events are free and open to the general public, which means that kids and adults of all ages are welcome to join. Every week we explore a different fun math Activity.

If you are interested in volunteering to become a facilitator of the JRMF Webinars, please contact Dr. Jeanette Shakali, the JRMF Outreach and Marketing Consultant, at jeanette.shakalli@jrmf.org.

The EDGE Summer Program for Women is a four-week, residential session that takes place at a different university each year. Program participants attend daily lectures in subjects such as Algebra, Measure Theory, Numerical Linear Algebra, and Real Analysis. EDGE coursework is designed to prepare participants for graduate research and qualification exams, while also providing practical experience in a rigorous academic setting. Participants delve deeper into these subjects through collaborative daily problem sessions, with guidance from EDGE mentors, who are current graduate students and often EDGE alumnae.

Research presentations, colloquia, and community-building events fill out the program. Past EDGE participants attend the Annual Summer Symposium, a conference held during the Program, to present research and network with current participants, mentors, and facilitators. The personal and professional network built during the Program serves as a support structure for the EDGE participant cohort throughout their graduate studies and beyond. To read more about the program and apply go to: https://www.edgeforwomen.org/summer-session/. Please direct any questions to edgestaff@edgeforwomen.org.

jmm 2022 Joint Mathematics Meetings

Call for proposals for JMM 2022 If you have a topic that you would like to explore with the community, now is the time to put your great idea into motion. The American Mathematical Society (AMS) invites all members of the mathematics community to submit proposals for JMM 2022 events. The JMM, the largest annual mathematics gathering in the world, is scheduled to take place January 5-8, 2022, in Seattle. JMM 2022 features an expanded classification system for sessions and talks in addition to existing MSC classifications to cultivate a broader range of presentations on mathematics research, pedagogy, inclusion, and more. A media release with a detailed call for proposals can be found here. The portal is now open, and all proposals must be submitted by April 7, 2021.

BEAM

Bridge to Enter Advanced Mathematics

Summer Positions Available!

This summer, *change the lives* of underserved students with exceptional potential in mathematics.

Bridge to Enter Advanced Mathematics is a free program for students from low-income and historically marginalized communities who show exceptional potential in mathematics.

All students and staff at Union College in Summer 2019

For Summer 2021, we are hiring...

...college professors and classroom teachers as faculty. Design your own courses on favorite math topics. Teach to small classes of motivated middle schoolers.

...graduate students as junior faculty, designing and teaching courses with structured support and mentorship.

...college students as student life counselors and teaching assistants.

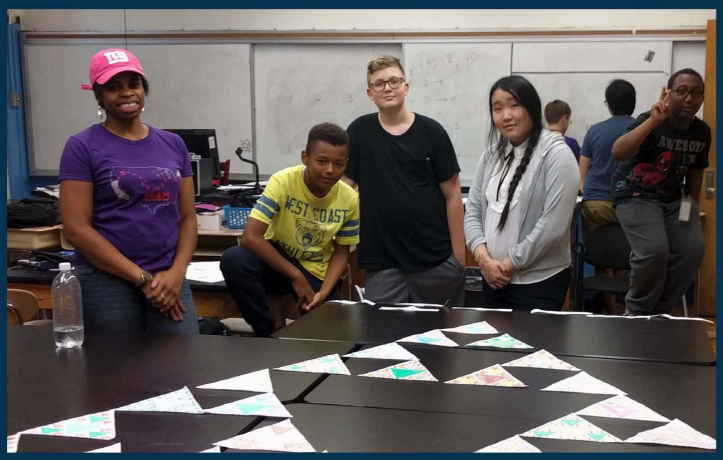
COVID-19 Note: We have not yet made a decision about whether we will be running 2021 programs in person or virtually. Please see our website for updates on this and for more information about salary and other compensation.

For more information and how to apply:

beammath.org/jobs

"Teaching at [BEAM] was a great joy, and I highly recommend it as an outreach initiative to get involved in!"

- Professor Mohamed Omar, Harvey Mudd College



Faculty member Evelyn Owhor with students in NYC 2018

Job Openings

Ohio Wesleyan University - Department of Mathematics and Computer Science

Ohio Wesleyan University's Department of Mathematics and Computer Science invites applications for **two tenure track Assistant Professor positions** (one in applied mathematics and one in computer science) to begin in August 2021. We seek enthusiastic instructors with a demonstrated interest in mathematics/computer science in applied fields. Qualified candidates will (1) be excellent teachers, able to teach a variety of undergraduate applied mathematics/computer science courses at all levels, (2) be eager to participate in the department's efforts to engage in mentored research opportunities with students, (3) maintain a productive, ongoing research program, and (4) contribute actively to the growth of the department and its efforts to attract and retain a diverse student body. For more information, please see our postings on mathjobs.org and on our OWU webpage at `https://owu.edu/joinOWUfaculty`. Applications submitted by January 15, 2021 will receive full consideration.

United States Naval Academy – Mathematics Department

The Mathematics Department at the United States Naval Academy in Annapolis, Maryland, invites applications for the **William R. Davis '68 Distinguished Chair in Mathematics**. An initial appointment of one year is anticipated, with a possibility for renewal for an additional year. Holders of the Distinguished Chair could be career academics (possibly on sabbatical) with strong research programs, up-and-coming postdocs who are rising stars in their disciplines, researchers at government labs or agencies, technical leaders in industry, or other exceptional candidates. The Distinguished Chair is expected to be an active participant in the department.

Their involvement might include mentoring midshipmen and faculty, or developing our research and teaching capabilities, particularly in their field of specialization. The Distinguished Chair will teach one course per semester, perhaps co-teaching advanced classes in their field alongside USNA faculty members. While any area of expertise will be considered, the department is particularly interested in candidates who can contribute to our programs in operations research, statistics, data science, econometrics, or applied mathematics. Candidates are directed to our official job postings at `https://www.usna.edu/HRO/jobinfo/DavisDVP-AY21.php` for details about the posi-

tion and requirements (including US citizenship and a background investigation).

Application review will begin on February 28, 2021 and will continue until the position is filled.

Brandeis University – Department of Mathematics

BRANDEIS UNIVERSITY Department of Mathematics invites applications for a **tenure-track position in applied mathematics at the rank of assistant professor** beginning Fall 2021. Candidates must have a Ph.D. in mathematics or a related field, demonstrate potential for excellence in research, and display a commitment to teaching. An ideal candidate will be expected to help to build an applied mathematics program within the department, and to interact with the broader student, staff, and faculty, including other science faculty at Brandeis. Candidates from all areas of applied mathematics will be considered. More details at `https://www.mathjobs.org/jobs/list/16903`.

Franklin & Marshall College – Department of Mathematics

Franklin & Marshall College invites applications for a **Visiting Assistant Professor or Visiting Instructor position** (depending on qualifications) in the Department of Mathematics beginning Fall 2021. The successful candidate must possess or be close to completing a doctorate in Mathematics, Applied Mathematics, or Statistics. This position may be renewed for up to 3 years based on successful annual review and administrative approval. For more information and to apply go to: `http://apply.interfolio.com/83083`. Applications completed by March 15, 2021 will receive full consideration.

Drake University – Department of Mathematics and Computer Science

Drake University seeks outstanding candidates for a **tenure-track Assistant Professor of Mathematics**, beginning August 2020. Applicants must have an active research program and a strong commitment to undergraduate teaching. The course load is 6 courses/year. Review begins January 4, 2021. Drake University is an Equal Opportunity Employer dedicated to building a culturally diverse and pluralistic community. In the wake of the Black Lives Matter movement, it is especially important the candidate be attuned to issues involving students from under-represented backgrounds.

Details of the position as well as instructions on how to apply can be found at `https://drake.hiretouch.com/home/search-all-jobs` - use "mathematics" to search. Contact: daniel.alexander@drake.edu.

Carnegie Mellon University - Department of Mathematical Sciences

The Department of Mathematical Sciences at Carnegie Mellon University invites applications for a **tenure-track position at the rank of assistant professor or above** to begin September 1, 2021. This search is open to all areas of mathematics, and we are particularly interested in candidates who can broaden the scope of one or more of the department's existing research strengths, which include applied analysis, discrete mathematics, logic, mathematical finance, and probability.

Applicants should submit all materials electronically through `https://apply.interfolio.com/80604` and `www.mathjobs.org`. This includes a cover letter, curriculum vitae, list of publications, a statement describing current and planned research, a teaching statement, and a statement describing how, through their research, teaching and/or service, they plan to contribute to and foster diversity and inclusion in mathematics. Candidates should provide at least three letters of recommendation that will be solicited through Mathjobs. We will begin to review applications on January 4, 2021. Applications may be accepted and reviewed until the position is filled.

Carnegie Mellon University – Department of Mathematical Sciences

The Department of Mathematical Sciences at Carnegie Mellon University expects to appoint a **Shelly Visiting Associate Professor** for the 2021-2022 academic year. This position, created through a gift of Eugene P. Shelly, is intended for regular mathematics faculty members at institutions that focus primarily on teaching. The idea is to give Carnegie Mellon faculty and graduate students an opportunity to improve their teaching skills through interaction with the candidate, while simultaneously providing the candidate with an enriched research experience.

Review of applications will begin on March 1, 2021 and continue until the position is filled. The Department of Mathematical Sciences is committed to increasing the number of women and minority faculty. Carnegie Mellon considers applicants for employment without regard to, and does not discriminate on the basis of, gender, race, protected veteran status, disability, or any other legally protected status.

Successful applicants will be expected to provide evidence of a strong teaching record. Appointment at the level of Visiting Assistant Professor or Visiting Professor may also be considered. Applicants should submit all materials electronically through MathJobs (`www.mathjobs.org`) and Interfolio (`apply.interfolio.com/82510`). This includes a curriculum vitae, list of publications, a statement describing teaching accomplishments, and three letters of recommendation to be solicited via MathJobs.

Colby College – Department of Mathematics

We anticipate two visiting assistant professor positions in mathematics, September 1, 2021 – June 30, 2022, and seek outstanding teachers with research interests that mesh with those of the continuing mathematics faculty in the department. Candidates must have a Ph.D. in mathematics and must have significant teaching experience as instructors of record. Please see our full ad at
`http://www.colby.edu/mathstats/faculty-searches/` for more information and application instructions. All materials should be submitted online at `www.mathjobs.org`. Review of applications will begin on March 1, 2021, and will continue until the position is filled.

Syracuse University – Department of Mathematics

The Department of Mathematics, Syracuse University, seeks to fill a tenure-track position in the area of Analysis at the assistant professor level, beginning August 2021. Preference will be given to candidates with expertise in Mathematical Material Science/Applied Analysis.

A PhD in a related field is required; PhD in Mathematics is preferred. Previous Post-doctoral experience is also preferred. Candidates should have a record of accomplishment and potential in both research and teaching.

The department seeks candidates whose research, teaching, or service has prepared them to contribute to our commitment to diversity and inclusion. Women and other members of groups who are underrepresented in higher education, and in mathematics specifically, are strongly encouraged.

Applications must be done in two steps:
Step 1: Candidates must submit an online faculty application with a CV at
`https://www.sujobopps.com`
Step 2: Candidates must submit a cover letter, CV, a research and a teaching statement, three letters of recommendation addressing research qualifications, and at least one letter of recommendation addressing teaching at `http://www.mathjobs.org/jobs`).

Syracuse University is an Equal Opportunity/Affirmative Action Employer committed to fostering a diverse faculty. Women and minority candidates are especially encouraged to apply.

Syracuse University – Department of Mathematics

The Department of Mathematics at Syracuse University invites applications for a tenure-track position in the area of Statistics at the Assistant Professor level, beginning August 2021.

This recruitment is part of an ambitious Invest Syracuse Cluster Hire Initiative. As an integral part of this investment, Syracuse University will recruit multiple candidates for faculty positions for a research cluster in the focus area of Big Data and Data Analytics. Faculty hired into these positions will participate in an organized research cluster that spans multiple departments in the College of Arts and Sciences and in the College of Engineering and Computer Science, Falk College of Sport and Human Dynamics, Whitman School of Management, and School of Information Studies.

The proposed position is for a Statistician whose research interests are in developing methodologies for the analysis of high-dimensional complex data related to physical and biological science applications. The position will also create strong synergistic effect on current statisticians in Mathematics, whose research interests include Bayesian Statistics & nonparametric/semi-parametric analysis.
See `http://thecollege.syr.edu/mathematics` for more information. The new hire will also provide support for statistics education at the undergraduate/graduate level, including creating new courses in Data Science in the Mathematics Department.

A PhD in Statistics or in Mathematics with an emphasis in Statistics is required. Previous postdoctoral experience is preferred. Candidates should have a record of accomplishment and potential in both research and teaching.

The department seeks candidates whose research, teaching, or service has prepared them to contribute to our commitment to diversity and inclusion. Women and other members of groups who are underrepresented in higher education, and in mathematics specifically, are strongly encouraged to apply.

Applications must be done in two steps:

Step 1: Candidates must submit an online faculty application with a CV at

`https://www.sujobopps.com`

Step 2: Candidates must submit a cover letter, CV, research and teaching statements, three letters of recommendation addressing research qualifications, and at least one letter of recommendation addressing teaching at Mathjobs.org.
(`http://www.mathjobs.org/jobs`).

Screening of candidates begins immediately and continues until the position is filled.

University of Dayton – Department of Mathematics - Topology

The Department of Mathematics at the University of Dayton seeks applicants with expertise in topology for a tenure track position at the assistant professor level starting August 16, 2021.

We are looking for someone who wants to thrive in a collegial and supportive environment, who will grow as a professional and will contribute to the understanding of mathematics through research in topology, who is committed to educating the next generation of mathematics students in a setting where a variety of teaching strategies is encouraged, and who is committed to growing participation of women and underrepresented minorities in mathematics. The successful candidate will be expected to maintain an active research agenda and will be encouraged to seek opportunities to collaborate with researchers within the department, the university, and/or the wider community. The typical teaching load is three courses each semester, two of which will usually support the mission of the Department to teach mathematics courses for non-mathematics majors. There will also be opportunities to teach upper division courses for mathematics majors. The successful candidate will be also expected to participate in the life and development of the Department of Mathematics, and work with students from diverse backgrounds both in the classroom and on mathematical research and capstone projects as such opportunities arise.

Applicants must have active and ongoing research in an area of topology (MSC 54, 55). Applicants must also possess effective written communication skills and have the potential to become an effective teacher of mathematics. Applicants must be ABD with completion of all requirements for the PhD in mathematics by July 1, 2021.

For a complete list of preferred qualifications, application details, and to apply go to: https://employment.udayton.edu/cw/en-us/job/498479/assistant-professor-specializing-in-topology

A complete application consists of a cover letter, CV, a brief statement of research agenda, a statement of teaching philosophy, a listing of all courses the applicant has taught, an unofficial graduate school transcript (which must confirm the PhD if it has been earned at time of application), and contact information for the writers for three letters of recommendation. Teaching abilities must be addressed in at least one letter and research abilities must be addressed in at least one letter. Applicants whose PhD has not been conferred at the time of application must submit a statement from their degree-granting department indicating the anticipated timeline for completion of the Ph.D. degree. Applications are due by March 7, 2021. The posting closes at 11:55 PM EST. All letters of reference are due 7 days after the candidate has completed the application process.

More information about our department can be found at
http://go.udayton.edu/math

The University of Dayton is a top tier, Catholic research university with offerings from the undergraduate to the doctoral levels. Founded in 1850 by the Society of Mary, the University is a diverse community committed to advancing the common good through intellectual curiosity, academic rigor, community engagement and local, national and global partnerships. Guided by the Marianist educational philosophy, we educate the whole person and link learning and scholarship with leadership and service. Informed by its Catholic and Marianist mission, the University is committed to the principles of diversity, equity, and inclusion. Informed by this commitment, we seek to increase diversity, achieve equitable outcomes, and model inclusion across our campus community. As an Affirmative Action and Equal Opportunity Employer, we will not discriminate against minorities, women, protected veterans, individuals with disabilities, or on the basis of race, color, national origin, religion, sex, sexual orientation or gender identity.

The University is also pleased to provide support for spouses of prospective and newly hired faculty through its dual career program. While we cannot guarantee placement, we serve as an effective resource and support system for your spouse. Information can be found at
http://www.udayton.edu/hr/employee_resources/dual_career_resources.php

University of Dayton – Department of Mathematics - Statistics

The Department of Mathematics at the University of Dayton seeks applicants with expertise in statistics for a tenure track position at the assistant professor level starting August 16, 2021.

The person filling this tenure-track position is expected to bring to the department expertise in an area of statistics. The successful candidate is expected to maintain an active research agenda in statistics and to collaborate with researchers within the department, the university, and/or the wider community when opportunities arise. The candidate is expected to participate in the life and development of the Department of Mathematics and to work with students from diverse backgrounds both in the classroom and on research and capstone projects as opportunities arise. Responsibilities include teaching three courses per semester including service courses populated primarily by non-majors, upper-level undergraduate courses for mathematics and other STEM majors, as well as graduate courses in statistics. The department is planning on developing curriculum in the area of data analytics, and the successful candidate is expected to assist in these efforts. The successful candidate is also expected to mentor and advise

undergraduate or graduate students where opportunities are present.

The Department of Mathematics has a diverse faculty with a broad range of research interests including Statistics. The current statisticians in the department actively engage in collaborative research with a variety of departments within the university, as well as organizations outside the university. Opportunities are available to participate in both funded research and unfunded graduate student research including advising students and serving on research committees. The department also teaches a broad range of statistics courses from Introductory Statistics to special topics geared toward graduate students.

Applicants must be ABD with completion of all requirements for the PhD in statistics by July 1, 2021. Applicants must also have: the potential to become an effective teacher of statistics courses; an active and ongoing research in statistics; an articulated interest in developing new curriculum in data analytics; and effective written communications skills. For a complete list of preferred qualifications, application details, and to apply go to: https://employment.udayton.edu/cw/en-us/job/498482/assistant-professor-specializing-in-statistics

A complete application consists of a cover letter, CV, a brief statement of research agenda, a statement of teaching philosophy, a listing of all courses the applicant has taught, an unofficial graduate school transcript (which must confirm the PhD if it has been earned at time of application), and contact information for the writers for three letters of recommendation. Teaching abilities must be addressed in at least one letter and research abilities must be addressed in at least one letter. Applicants whose PhD has not been conferred or reflected on their transcript, at the time of application must submit a statement from their degree-granting department indicating the anticipated timeline for completion of the Ph.D. degree. Applications are due by March 8, 2021. The posting closes at 11:55 PM EST. All letters of reference are due 7 days after the candidate has completed the application process.

More information about our department can be found at `http://go.udayton.edu/math` The University of Dayton is a top tier, Catholic research university with offerings from the undergraduate to the doctoral levels. Founded in 1850 by the Society of Mary, the University is a diverse community committed to advancing the common good through intellectual curiosity, academic rigor, community engagement and local, national and global partnerships. Guided by the Marianist educational philosophy, we educate the whole person and link learning and scholarship with leadership and service. Informed by its Catholic and Marianist mission, the University is committed to the principles of diversity, equity, and inclusion. Informed by this commitment, we seek to increase diversity, achieve equitable outcomes, and model inclusion across our campus community. As an Affirmative Action and Equal Opportunity Employer, we will not discriminate

against minorities, women, protected veterans, individuals with disabilities, or on the basis of race, color, national origin, religion, sex, sexual orientation or gender identity.

The University is also pleased to provide support for spouses of prospective and newly hired faculty through its dual career program. While we cannot guarantee placement, we serve as an effective resource and support system for your spouse. Information can be found at
`http://www.udayton.edu/hr/employee_resources/dual_career_resources.php`

Canada/USA Mathcamp – Graduate Student Mentors

Canada/USA Mathcamp (`www.mathcamp.org`) is looking for math graduate students as Mentors for its summer 2021 session:

June 28 to August 12, 2021 · Location: online · Compensation: $5,100 plus expenses
Apply by: February 28, 2021 · Learn more: ***`http://www.mathcamp.org/mentor/`***

Mathcamp brings a diverse and talented group of 120 marvelous teenagers together each summer to explore advanced topics in mathematics and find a true peer group. The Mentor job is a hybrid between a teaching position and a camp counselor role.

As a Mentor at Mathcamp, you get an amazing teaching experience: there is no set curriculum, so you create your own classes and teach what most interests you—from group theory to projective geometry to voting theory—in an atmosphere of freedom and excitement. You'll have support from master teachers, and you'll work with students who are exceptionally smart and engaged. Mentors are also the camp's primary leaders and organizers, wearing many hats: running informal activities, setting organizational policy, and bringing to life the "camp" side of Mathcamp. It is both an intense and immersive six weeks, even in the all-virtual format: a lot of work, but also extremely rewarding.

Strong candidates for this role are typically PhD students in pure or applied math. Those with a similar background in advanced mathematics and teaching are welcome to contact us about applying to be faculty. It is important to us to hire and support a diverse staff who serve as role models to our students.

Passing of Dr. Frank Hawkins

Aliakbar Montazer Haghighi

Dr. Frank Hawkins

It is with heartbreak that I must inform you of the passing of Professor Dr. Frank Hawkins, who was previously the Department Head of Mathematics at Prairie View A&M University. On behalf of the Department of Mathematics and myself, our condolences to Dr. Hawkins' family, in particular to Dr. Hawkins' wife, Dr. Mary S. Hawkins, who is a retired faculty member of the Whitlow R. Green College of Education.

Dr. Frank T. Hawkins, retired Professor of Mathematics at Prairie View A&M University passed on Monday December 21, 2020. During his 39 years at PVAMU, he served as Chair of the Freshmen Studies Mathematics Program and Head of the Mathematics Department. Dr. Hawkins was the Founder of the Research Association of Minority Professors (RAMP). He was a lifetime member of the National Association of Mathematicians and Phi Beta Sigma Fraternity, Inc.

Dr. Hawkins' family has asked that in lieu of flowers, donations be made to the Frank T. Hawkins Endowment Scholarship at Prairie View A&M University (giving.pvamu.edu or (936)261-1550, which was established at his retirement from the university in 2004.

Aliakbar Montazer Haghighi *is a Professor and Head of Department of Mathematics at Prairie View A&M University. He can be contacted at* `amhaghighi@pvamu.edu`. □

You Are Invited to Donate to NAM's PIEF, NAM's Endowment Fund

During the years 2017 – 2019, NAM conducted a **successful NAM 50th Anniversary Year (2019) Campaign** which produced most of the current **very low six figure fund** that constitute NAM's 2020 Endowment Fund which is called NAM's PIEF (NAM's Perpetual Investment and Endowment Fund). It is the goal of NAM to increase NAM's PIEF to be at least a $1,000,0000 Endowment Fund by NAM's 55th Anniversary Year (2024). NAM needs this Endowment Fund to ensure that it will be able to plan ahead and implement, annually, all of NAM's Signature and Seasonal Programs and Activities at levels (attendance-wise) that have been very effective in the past. **The Principal of the Endowment Fund will increase continuously. Only the annual yield of dividends, interests, and annuities will be used for expenses** to HELP support NAM's Signature and Seasonal Programs and Activities when insufficient grant monies or membership dues are not available during a given year.

What kind of Donations are accepted in NAM's Endowment Fund?

A. Get a Life Membership in NAM ($1,000);
B. Make a Special Philanthropic Donation to NAM of $1,000 or more; or
C. Partially or fully endow one of NAM's Signature Programs or Activities.
D: How To Fully or partially Endow one of NAM's Signature Programs or Activities:

1. **The Haynes-Granville-Browne PhD Presentations; $50,000, Fully; $10K+, partially**
2. **Cox-Talbot Address $50,000, Fully; $10K +, partially**
3. **Claytor-Woodard Lecture $50,000, Fully; $10k+, partially**
4. **Stephens-Shabazz Teaching Award $50,000, Fully; $10 k+, partially**
5. **David Blackwell Lecture $50,000, Fully; $10k+, partially**
6. **J. Ernest Wilkins Lecture $50,000, Fully; $10k+, partially**
7. **A. T. Bharucha-Ried Lecture $50,000, Fully; $10k+, partially**
8. **NAM FCRTE (NAM Annual Faculty Conference) $150,000, Fully; $25k+, partially**
9. **NAM Annual Undergraduate MATHFest $300,000, Fully; $50k+, partially**

E. Other ways to Donate: 1. Include NAM in your Will; 2. Bequeath NAM a Gift ($5000+); 3. Make NAM a Beneficiary of an Insurance Policy; 4. Give NAM a Gift in Honor of a special person/mathematician/mathematics educator/etc

ALL DONATIONS WILL BE ACKNOWLEDGED BY A CERTIFICATE OF GIFT. Send Donations to NAM Treasurer: treasurer@nam-math.org, Cory Colbert. NAM is a 501 (c) 3 organization; ALL DONATIONS ARE TAX DEDUCTIBLE.

Bolstering the Advancement of Masters in Mathematics

BAMM!

Join our supportive and growing community of master's students and faculty mentors!

BAMM! CSU Sites:

- Cal Poly Pomona
- Fresno State
- San Francisco State University

Contact:

- John Rock, Cal Poly Pomona (jarock@cpp.edu)
- Kimberly Seashore, San Francisco State University (kimseash@sfsu.edu)
- Oscar Vega, Fresno State (ovega@csufresno.edu)
- Robin Wilson, Cal Poly Pomona (robinwilson@cpp.edu)

What is BAMM?

The BAMM! program provides financial support and mentoring for Master's students who wish to pursue a Ph.D. in the mathematical sciences. BAMM! is a fulfilling, cohort-based program in which each participant receives up to **$20,000** in scholarships (up to $10,000 annually for academic years 2021-22 and 2022-23) at any of the three BAMM! CSU sites. Key features of BAMM! include but are not limited to a supportive community of fellow students and mentors, advanced coursework in the mathematical sciences, research experiences, continual guidance, and opportunities to attend conferences to network and gain experience presenting results.

Application Requirements

- A personal statement addressing a desire to pursue a Ph.D. in the mathematical sciences, including Pure Mathematics, Applied Mathematics, Statistics, and Mathematics Education.
- Two recommendation letters from mathematical sciences faculty.
- Unofficial transcripts from bachelor's-granting institution.
- A bachelor's degree conferred by August 2021.
- **Application Deadline: April 12, 2021.** (Apply online.)
- **Website:** https://tinyurl.com/y79hutaz

Eligibility

Applicants for the BAMM! program must:

- Be eligible for Financial Aid.
- Be U.S. citizens or permanent residents.
- By Fall 2021, be enrolled in a Master's program in the mathematical sciences at a BAMM! CSU site: Cal Poly Pomona, Fresno State, or San Francisco State University.

Low-income students with demonstrated financial need and students from underrepresented groups in the mathematical sciences are particularly encouraged to apply.

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Spring 2021