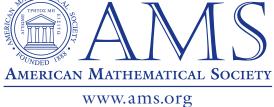# National Association of Mathematicians, Inc.
Undergraduate MATHFest XXVII

www.ams.org

September 29 – October 1, 2017

Medgar Evers College

Brooklyn, New York

http://nam-math.org/mathfest.html#XXVII

NAM's Undergraduate MATHFest XXVII

The National Association of Mathematicians (NAM) is a non-profit professional organization in the mathematical sciences with membership open to all persons interested in the mission and purpose of NAM which are (1) promoting excellence in the mathematical sciences and (2) promoting the mathematical development of all underrepresented minorities. NAM was founded in 1969; in 2019, we will celebrate our 50th anniversary.

NAM has five meetings every year: the Joint Mathematics Meetings in the Winter; and the Regional Faculty Conference on Research and Teaching Excellence (FCRTE) in the Spring; the Computational Sciences Institute in the Early Summer Fall; the MAA MathFest in the Late Summer; the NAM MathFest in the Fall. NAM's Undergraduate MATHFest is a three-day meeting, typically Friday through Sunday in the Fall, which rotates around the country based on NAM's regional structure. It is held annually to encourage students to pursue advanced degrees in mathematics and mathematics education. The conference is geared for undergraduates from Historically Black Colleges and Universities (HBCUs), although all are welcome to attend. The conference consists of five components:

- **Student Talks**
  There will be ten talks given by undergraduate and graduate students which last 30-minutes each. Each talk should be 20 minutes long, allowing for 10 minutes of questions and answers. There will be a friendly competition for the most outstanding oral presentation.

- **Poster Presentations**
  Students have the opportunity to present posters outlining their research. The Poster Session will take place Saturday afternoon from 3:30 PM - 5:00 PM. There will be a friendly competition for the most outstanding poster presentation.

- **Graduate Fair**
  Universities will have an opportunity to showcase their graduate programs and interact with undergraduate students in a two-hour fair. The Gradute Fair will take place Saturday afternoon from 3:30 PM - 5:00 PM.

- **Problem Time with Dr. Cooper**
  Throughout the conference, students will be presented challenge problems. Students with correct solutions will be presented prizes.

- **The J. Ernest Wilkins Lecture**
  This is an hour-long talk, given by an established researcher, to motivate our undergraduates to continue to pursue research in the mathematical sciences. This year's Wilkins Lecturer is Stephon Alexander (Brown University); his talk will be Friday from 4:00 PM - 5:00 PM.

We are thankful to sponsorship of the prizes for the talks, poster session, and "Problem Time" by Helen Grundman and the American Mathematical Society (AMS). More information about the conference can be found at the website `http://nam-math.org/mathfest.html`.

Which MathFest Came First?

NAM's Undergraduate MATHFest began in 1991, and it inspired other similar undergraduate-focused conferences over the years.

- The Mathematical Association of America (MAA) MathFest began in 1997, with a meeting in Atlanta, Georgia. According to Zitarelli:

  > A historic change for MAA national meetings took place in 1996 when the AMS voted to disband its summer gatherings. The MAA decided to continue alone, adopting the name "MathFest" starting in 1997, and has sponsored this meeting every summer since then.

- The American Statistical Association (ASA) StatFest began in 2001, with a meeting on November 1, 2001 at Spelman College.

- The National Math Festival, a biennial conference which began in 2015, was originally slated to be called "MathFest." In fact, the domain name `MathFest.org` redirects to this conference.

National Association of Mathematicians, Inc.
Undergraduate MATHFest XXVII

MORGAN'S LEADERSHIP IN THE CIVIL RIGHTS MOVEMENT: 1947-1963

Friday, September 29 - Sunday, October 1
Medgar Evers College

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2017 J. Ernest Wilkins Lecture
Stephon Alexander
Professor of Physics, Brown University

http://www.nam-math.org/mathfest.html#XXVII

J. Ernest Wilkins Lecture

Stephon Alexander, Professor of Physics at Brown University

TBA

ABSTRACT: TBA

BIOGRAPHY: Physicist and Musician Stephon Alexander has straddled the two worlds of theoretical physics and jazz music over the last two decades. He obtained his Bachelors of Science from Haverford College and Doctorate from Brown and was a research physicist at Imperial College, London and the Stanford Linear Accelerator Center, Stanford University.

On the physics front Alexanders works on the connection between the smallest and largest entities in the universe pushing Einsteins theory of curved space-time to extremes, beyond the big bang with sub atomic phenomena. Alexander is a specialist in the field of string cosmology, where the physics of superstrings are applied to address longstanding questions in cosmology. In 2001, he co-invented the model of inflation based on higher dimensional hypersurfaces in string theory called D-Branes. In such models the early universe emerged from the destruction of a higher dimensional D-brane which ignites a period of rapid expansion of space often referred to as cosmic inflation.

Jesse Ernest Wilkins, Jr.

The **J. Ernest Wilkins Lecture** series was inaugurated in 1994 during NAM's Undergraduate MATHFest IV at North Carolina A&T. It is named in honor of Jesse Ernest Wilkins, Jr. (November 27, 1923 – May 12, 2011), an internationally recognized nuclear scientist, mechanical engineer and mathematician.

J. Ernest Wilkins was known in the press as the "Negro Genius." Wilkins received his B.S. degree as a Phi Beta Kappa graduate at the age of 16, his M.S. degree at age 17, and his Ph.D. degree at the age of 19. Although he has been highly praised as a superb practitioner of his crafts, Wilkins is also widely recognized and acclaimed as a highly productive scholar, having published more than 80 journal articles and having produced an additional 22 unpublished reports for the Atomic Energy Commission. Wilkins is the only African American mathematician-engineer elected as a Fellow to the National Academy of Engineering (NAE).

The inaugural lecture was given by Wilkins himself. The Lecture is to be given annually at the Undergraduate MATHFest, a conference for which Wilkins was a frequent attendee.

Conference Schedule

Friday, September 29	
1:00 PM - 4:00 PM EOJ	On-Site Registration
1:30 PM - 1:45 PM Marriott at the Brooklyn Bridge	Shuttle Leaves Marriott Plaza for Medgar Evers
2:00 PM - 2:30 PM EOJ	**Greetings and Conference Orientation** Edray Herber Goins, President of NAM Terrence Blackman, Dean (Acting) of The School of Science, Health and Technology at Medgar Evers College [OTHERS]
AFTERNOON SESSION	**Moderator: TBA**
2:30 PM - 3:00 PM C-13	*On the Maximal Number of Roots of a Trinomial Over a Prime Field* Jeshu Dastidar (Queens College)
3:00 PM - 3:30 PM C-13	*Computing Commuting Partitions* Carlos Samuels (Medgar Evers College)
3:30 PM - 4:00 PM L-12	Beverage Break
4:00 PM - 5:00 PM EOJ	**J. Ernest Wilkins Lecture** *TBA* Stephon Alexander (Brown University)
6:30 PM - 6:45 PM [ROOM]	Shuttle Returns to Marriott
Saturday, September 30	
8:00 AM - 8:15 AM Marriott at the Brooklyn Bridge	Shuttle Leaves Marriott Plaza for Medgar Evers
8:00 AM - 9:00 AM AB1-312	**Continental Breakfast** Catered by TBA
8:00 AM - 12:00 PM EOJ	On-Site Registration

MORNING SESSION	Moderator: TBA
9:00 AM - 9:30 AM C-13	*Detecting Bovine Lameness Using Three-Dimensional Limb Movement Variable Analysis to Achieve High Sensitivity and Specificity* William Dula (Morehouse College)
9:30 AM - 10:00 AM C-13	*On the Roots of Lower Binomials* Harold Jimenez-Polo (University of California at Berkeley)
10:00 AM - 10:30 AM L-12	Beverage Break
10:30 AM - 11:00 AM C-13	*Counting The Roots of Polynomials Modulo p^2* Trajan Hammonds (Carnegie Mellon University)
11:00 AM - 11:30 AM C-13	*Student Talk #6* TBA
11:30 AM - 12:00 PM L-12	**Problem Time with Dr. Cooper** Round 1 of 3
12:00 PM - 1:00 PM AB1-312	**Lunch** Catered by TBA
AFTERNOON SESSION	Moderator: TBA
1:00 PM - 1:30 PM C-13	*Homotopy Commutative Algebras, Knots and Graphs* Maksym Zubkov (University of California at Irvine)
1:30 PM - 2:00 PM C-13	*Student Talk #8* TBA
2:00 PM - 2:30 PM Meet at Security Desk	Group Photo
2:30 PM - 3:00 PM L-12	**Problem Time with Dr. Cooper** Round 2 of 3
3:00 PM - 3:30 PM AB-1/Lobby	Break Graduate Fair and Poster Set-Up
3:30 PM - 5:00 PM AB-1/Lobby	Graduate Fair / Poster Session
5:15 PM - 5:30 PM [ROOM]	Shuttle Returns to Marriott
7:00 PM - 9:00 PM Marriott at the Brooklyn Bridge	**Undergraduate MATHFest XXVII Appreciation Dinner**

Sunday, October 1	
8:00 AM - 8:15 AM Marriott at the Brooklyn Bridge	Shuttle Leaves Marriott Plaza for Medgar Evers
8:00 AM - 9:00 AM AB1-312	**Continental Breakfast** Catered by TBA
MORNING SESSION	**Moderator: TBA**
9:00 AM - 9:30 AM C-13	*TBA* Joshua Sparks (Morehouse College)
9:30 AM - 10:00 AM C-13	*Student Talk #10* TBA
10:00 AM - 10:30 PM L-12	**Problem Time with Dr. Cooper** Round 3 of 3
10:30 AM - 11:00 AM L-12	Beverage Break Judges Tally Scores
11:00 AM - 11:45 AM EOJ	**Awards Ceremony**
11:45 AM - 12:00 PM EOJ	Closing Remarks
12:00 PM - 1:00 PM AB1-312	**Lunch** Catered by TBA

Attendees

Name	Affiliation	E-Mail
Stephon Alexander	Brown University	Stephon_Alexander@brown.edu
Federico Ardila	San Francisco State University	federico@sfsu.edu
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Ron Buckmire	National Science Foundation	rbuckmir@nsf.gov
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Joshua Sparks	Morehouse College	joshua.sparks@morehouse.edu
Maksym Zubkov	University of California at Irvine	mzubkov@uci.edu

Abstracts

1. Jeshu Dastidar (Queens College)

   On the Maximal Number of Roots of a Trinomial Over a Prime Field

   Friday from 2:30 PM - 3:00 PM

   Canetti, Friedlander, et al. (2002) studied the randomness of powers over finite fields and along the way derived an analogue of Descartes' rule over the finite field $\mathbb{F}_q$ with q elements: They showed that the number of roots of any univariate t-nomial, with exponents, $\{0, a_2, \ldots, a_t\}$ and the differences $a_i - a_j$ all relatively prime to $q - 1$, is $O(q^{((t-2)/(t-1))})$. The correct optimal bounds remain a mystery for prime fields, even in the case of polynomials with three terms. Following the work of Kelley (2016), we expand current evidence by using a supercomputer to determine the number of roots of these trinomials for $139,571 < p \leq 191,491$. We also prove that the search can be restricted to trinomials with a middle linear term when $p - 1$ has less than three distinct prime factors.

2. William Dula (Morehouse College)

   Detecting Bovine Lameness Using Three-Dimensional Limb Movement Variable Analysis to Achieve High Sensitivity and Specificity

   Saturday from 9:00 AM - 9:30 AM

   Bovine lameness is a common issue among commercial dairy farms, resulting in decreased productivity. In order to treat bovine lameness effectively, it is necessary that it is detected early. The main objective is to model the lameness status of a cow using three-dimensional limb movement measurements related to the cow's gait. Previously, a statistical model was generated using the software SAS with its LOGISTIC and TRANSREG procedures. The model produces a binary classification: lame or sound. Current implementation requires running several SAS procedures manually and therefore is not amenable to a large scale application. In this work, we implement regression algorithms in R to mirror the TRANSREG procedure and thus speed up exploration of a large number of candidate models to maximize goodness of fit criteria such as the area under the Receiver Operating Characteristic curve (AUC). The predictive models are also evaluated using quantities such as sensitivity (true positive rate) and specificity (true negative rate) which are quite important from the dairy industry's point of view. We also consider multinomial logistic models to divide the lame cows further into severely lame and mildly lame. These results can ultimately be used in the commercial dairy industry for early lameness detection.

3. Trajan Hammonds (Carnegie Mellon University)

   Counting The Roots of Polynomials Modulo p^2

   Saturday from 10:30 AM - 11:00 AM

   Until recently, the only known method of finding the roots of polynomials over prime power rings, other than fields, was brute force. One reason for this is the lack of a division algorithm, obstructing the use of greatest common divisors. Fix a prime $p \in \mathbb{Z}$ and $f \in (\mathbb{Z}/p^n\mathbb{Z})[x]$ any nonzero polynomial of degree d whose coefficients are not all divisible by p. For the case $n = 2$, we prove a new efficient algorithm to count the roots of f in $\mathbb{Z}/p^2\mathbb{Z}$ within time polynomial in $(d + \text{size}(f) + \log p)$, and record a concise formula for the number of roots, formulated by Cheng, Gao, Rojas, and Wan.

4. Harold Jimenez-Polo (University of California at Berkeley)

   On the Roots of Lower Binomials

   Saturday from 9:30 AM - 10:00 AM

   Given a univariate trinomial $f \in \mathbb{R}[x]$, we analyze the relation between the roots of f and the roots of the corresponding lower binomials. The roots of the lower binomials, conjecturally, provide high quality approximations of the roots of f. We implement Smale's α-criterion to analyze whether our approximations converge quickly under Newton's method. We know that under certain conditions every root of a lower binomial is an approximate root of a trinomial, and we expect to determine when at

least one root of a lower binomial is an approximate root in the sense of Smale. Moreover, we prove that f has the same number of positive roots as its lower binomials with high probability.

5. Carlos Samuels (Medgar Evers College)

   Computing Commuting Partitions

   Friday from 3:00 PM - 3:30 PM

   > A square matrix N is called nilpotent if $N^k = 0$ for some positive integer k. By the Jordan Normal Form Theorem, the conjugacy classes of nilpotent $n \times n$ matrices are in one-to-one correspondence with the partitions of n. We say that two partitions P and Q of n commute if there is a nilpotent matrix A of partition P and nilpotent matrix B of partition Q such that $AB = BA$. In this undergraduate research project we are using the open-source mathematics software system Sage to find partitions that commute with a partition $P = (u, u - r)$ where $u > r > 1$.

   > Let A be the generic matrix that commutes with a Jordan block matrix of type P. We have written a program that computes all the partitions that can be obtained by setting some of the variables in A equal to 0, and another program that computes all the partitions that can be obtained by letting the variables in A vary over all the values in a finite field.

6. Joshua Sparks (Morehouse College)

   TBA

   Sunday from 9:00 AM - 9:30 AM

   > TBA

7. Maksym Zubkov (University of California at Irvine)

   Homotopy Commutative Algebras, Knots and Graphs

   Saturday from 1:00 PM - 1:30 PM

   > The simplest form of knot theory involves the study of regular knot which is defined as a closed loop in three-dimensional Euclidean space $\mathbb{R}^3$. One of the main problem of knot theory is detecting whether the two given knots are the same or not. Mathematicians developed certain invariants (Alexander and Jones polynomials, Vassiliev invariants, and etc.) that partially solved that problem. One of the standard techniques is to construct for each knot a graph and study invariants on this graph. During my talk, we are going to talk about commutative and non-commutative versions of graph complex and the difference between them. Also, we will discuss the methods which are based on combinatorics of Eilenberg-Zilber contraction, "surjection operations" of McClure and Smith, and homological perturbation lemma. That graph homology complex will help us to compute the homology of the "graph configuration space" for a topological space X (i.e. an n-fold cartesian product X^n with some of its diagonals removed). This is expected to give a concrete combinatorial model for knot invariants recently defined via the abstract technique of factorization homology.

Previous NAM Undergraduate MATHFests

- MATHFest XXVII: September 29 - October 1, 2017 at Medgar Evers College (Region A)

- MATHFest XXVI: November 10-12, 2016 at Morgan State University (Region B)

- MATHFest XXV: October 29-31, 2015 at Morgan State University (Region B)

- MATHFest XXIV: Cancelled

- MATHFest XXIII: November 8-9, 2013 at Texas State University (Region C)

- MATHFest XXII: November 1-3, 2012 at Morgan State University (Region B)

- MATHFest XXI: November 3-5, 2011 at Dillard University (Region C)

- MATHFest XX: November 18-20, 2010 at Miami Dade College (Region A)

- MATHFest XIX: November 12-14, 2009 at the University of District of Columbia (Region B)

- MATHFest XVIII: November 13-15, 2008 at Texas Southern University (Region C)

- MATHFest XVII: November 8-10, 2007 at Spelman College (Region A)

- MATHFest XVI: November 9-11, 2006 at Howard University (Region B)

- MATHFest XV: November 10-12, 2005 at Texas Southern University (Region C)

- MATHFest XIV: October 7-9, 2004 at Morehouse College (Region A)

- MATHFest XIII: October 20 - November 1, 2003 at Delaware Statue University (Region B)

- MATHFest XII: October 2002 at Southern University of New Orleans (Region C)

- MATHFest XI: October 4-6, 2001 at Florida A&M (Region A)

- MATHFest X: October 26-28, 2000 at Morgan State University (Region B)

- MATHFest IX: October 21-23, 1999 at Texas Southern University (Region C)

- MATHFest VIII: October 21-23, 1998 at Benedict College (Region A)

- MATHFest VII: October 23-25, 1997 at Elizabeth City State University (Region B)

- MATHFest VI: October 24-26, 1996 at Xavier University (Region C)

- MATHFest V: October 26-28, 1995 at Clark Atlanta (Region A)

- MATHFest IV: October 13-15, 1994 at North Carolina A&T (Region B)

- MATHFest III: October 21-23, 1993 at Southern University (Region C)

- MATHFest II: March 18-20, 1993 at Spelman College (Region A)

- MATHFest I: November 1991 at Hampton University (Region B)