



Twenty-Fourth Annual

Pi Mu Epsilon

Regional Undergraduate Math Conference

November 6 – 7, 2009

Featured Speaker: Dan Kalman

American University

Funding for this conference is provided by NSF grant DMS-0846477 through the MAA Regional Undergraduate Conferences program, www.maa.org/RUMC.

FRIDAY EVENING

STUDENT TALKS

Time	Cofrin 11	Cofrin 15
6:00	Steve Anderson , Loras College “The Search for New Continued Fractions”	Kathleen Miller , St. Norbert College “Genome Exploration”
6:20	Amber Bakkum , Carthage College “Kepler's Third Law and Curve Fitting”	Aaron League , Bradley University “Knotted Proteins”
6:40	Kevin Greimel , Winona State University “Anatomy, Geometry, and Radio Repairmen: The Mathematics of Flawed Fretted Instruments”	Dan Gerber , Carthage College “Coincidence? I Think Not.”
7:00	Monica Welter , Loras College “Persistence in Undergraduate Mathematics”	Kelsey Quarton , Bradley University “Shapes and Symmetry”

DAN KALMAN

7:30 - 8:30 p.m.

Cofrin 11

“The Mathematical Elephant”

8:30 – 9:30

Face Off! The Mathematics Game Show

Cofrin 11

Ken Price, Steve Szydluk, John Koker, UW - Oshkosh

9:30 - ?

Pizza in Cofrin Basement Lounge

SATURDAY MORNING

8:30 **Registration**, conversation, coffee, juice, fruit, and rolls in Cofrin basement lounge

STUDENT TALKS

Time	Cofrin 11	Cofrin 15
9:10	Carson Sievert , St. John’s University “A Mathematical Perspective of Voting”	
9:30	Laura Buggy , College of St. Benedict “The Energy of Graphs”	Mark Leroy , Loras College “Complex Geometry”
9:50	Megan Wisniewski , Benedictine University “Counting Hexagonal Knot Mosaics”	Caesar Cai , St. Norbert College “Prime Number, Mersenne Number, and Mersenne Prime – Seeking the Largest Prime Number”
10:10	Corey Vorland , St. Norbert College “Modeling Diatom Growth in Trout Lake, Part 2”	Ben Koerner , UW – Stout “Mathematics behind RSA Encryption”
10:30	Pinal Shah , Benedictine University “The Dynamics of One-Predator Two-Prey Models for Integrated Pest Management”	Sergii S. Bilokhatniuk , St. Norbert College “Gödel Incompleteness Theorem and Artificial Intelligence”

DAN KALMAN

11:00 - noon

Cofrin 11

“Provincial Polynomia: Uncommon Excursions for the Seasoned Visitor”

DETAILED PROGRAM

Friday, November 6

5:00 p.m. Registration, socializing, cookies, and soda in Cofrin basement lounge.

6:00 - 7:15 **Student Talks** in Cofrin 11 and Cofrin 15

6:00 – 6:15
Cofrin 11

STEVE ANDERSON, Loras College
The Search for New Continued Fractions

Offering an alternative to decimal notation, continued fractions have many benefits when used for all sorts of numbers; the best of which is using it for irrational numbers. Along with giving a very good approximation for irrationals, continued fractions can even represent them an obvious pattern. This presentation will show the infinite, patterned continued fractions for quadratic irrationals, π and even show the derivation and the beginnings of a proof of the infinite continued fraction of $e/2$.

Cofrin 15

KATHLEEN MILLER, St. Norbert College
Genome Exploration

Due to high-throughput genomics, massive amounts of data on DNA protein structure and protein sequences are becoming rapidly available – at a faster rate than we can keep up! This data is only as useful as long as it is interpreted. Based on summer laboratory research in bioinformatics, we explore a biological question using statistical and computational models to create algorithms. These algorithms allow for comparison between databases allowing for further interpretation and exploration within genomes.

6:20 - 6:35
Cofrin 11

AMBER BAKKUM, Carthage College
Kepler's Third Law and Curve Fitting

Johannes Kepler was the first person to show the relationship between the period of a planet's orbit in years and the average distance from the sun in astronomical units. Later, this relationship between a planet's orbit and average distance was demonstrated using curve fitting. In this report, we illustrate how curve fitting represents this relationship as a higher order polynomial curve.

Cofrin 15

AARON LEAGUE, Bradley University
Knotted Proteins

Proteins, the molecules that play such an essential role in cellular processes, are made up of long strands of amino acids bonded together and then folded, on rare occasion into knotted conformations. A knot, from a mathematical perspective, is a closed curve in space with no self-intersections that cannot be deformed into a circle without passing through itself. The purpose of this research was to define and identify when a protein's structure is nearly knotted. This research was done cooperatively with Jose Colon and Jacob Ryan under the supervision of Ana Meyers and Dr. Isabel Darcy.

6:40 – 6:55
Cofrin 11

KEVIN GREIMEL, Winona State University
Anatomy, Geometry, and Radio Repairmen: The Mathematics of Flawed Fretted Instruments

Guitars and other fretted instruments have been constructed under false assumptions using trial and error correction methods since around 800 AD; the initial purpose of the research was simply to reposition the frets so that the instrument would play in tune. After describing how musical scales can be generated, why fretted string instruments are a unique combination of integers and real numbers, and the mathematical model of sound for standing waves on a string, a model will be developed predicting the frequency produced at any fret or position on the fretboard of an instrument. After validating using existing instrument geometry, the fret can be repositioned using this model, or digital correction can be applied to adjust the frequency output.

Cofrin 15

DAN GERBER, Carthage College
Coincidence? I Think Not

The Riemann hypothesis is considered by many to be one of the greatest unsolved problems in mathematics. It has many applications dealing with the distribution of prime numbers, and the proof of the Prime Number Theorem follows directly from its proof. The distribution of the complex zeroes of the Riemann zeta function closely resemble the eigenvalues of a random Hermitian matrix, a type of matrix which also has applications in quantum physics. In this talk, we will introduce and discuss random Hermitian matrices and their significance to the Riemann zeta function, as well as their use in quantum physics.

7:00 - 7:15

Cofrin 11

MONICA WELTER, Loras College
Persistence in Undergraduate Mathematics

Why do students become math majors? Why do non-math majors continue on with mathematics classes beyond general education requirements? What characteristics influence students' class choices? We will look at these questions and draw connections between positive and negative characteristics and their ability to influence mathematical persistence.

Cofrin 15

KELSEY QUARTON, Bradley University
Shapes and Symmetry

In this project, we explore the ideas of shape and symmetry. By looking at the groups of orthogonal transformations that fix symmetric shapes in space, we are able to act on shapes that are not quite symmetric, but may somewhat resemble polygons or polyhedra that we know to be symmetric. By comparing a dissymmetric shape to its image after an orthogonal transformation, we can quantify its amount of dissymmetry. We do so by performing various tests that we have formulated to create a grading scale that can be used to weigh the symmetry of such shapes. This is joint work with Beck Scofield, done under the supervision of Sam Schmidt and Dr. Jon Simon.

7:30 - 8:30

Cofrin 11

Invited Address: **DAN KALMAN, American University**

The Mathematical Elephant

To those outside of our field, math is a bit of a mystery. Beyond the familiar mathematics of arithmetic and algebra, what does the subject concern itself with? How does it really get used? And how can someone spend four years in college studying it? This talk will give a few answers. For those who already have a deep understanding of mathematics, the talk may help you answer questions about the nature of our subject. But whether you are a mathematical novice or expert, I hope this talk will increase your appreciation of some of the many facets of mathematics.

8:30 – 9:30

Face Off! The Mathematics Game Show in Cofrin 11

9:30 -- ????

Pizza Social in Cofrin Basement Lounge; everyone at the conference is welcome!

Saturday, November 7

8:30 a.m. **Registration**, conversation, coffee, juice, fruit, and rolls in Cofrin basement lounge

9:10 - 10:45 **Student talks** in Cofrin 11 and Cofrin 15

9:10 – 9:25
Cofrin 11

CARSON SIEVERT, St. John’s University
A Mathematical Perspective of Voting

The 2000 presidential election is one of the most well-known examples of how voting systems can yield undesirable outcomes. In theory, a phenomenon known as the “spoiler’s effect” could have helped George W. Bush win the decisive “swing-state” over Al Gore. Limiting adverse results such as this from occurring in three elections is addressed.

9:30 – 9:45
Cofrin 11

LAURA BUGGY, College of St. Benedict
The Energy of Graphs

I will present some results from my REU group this past summer as well as my own on the topics of the energy of graphs. In particular, I will talk about the patterns I’ve observed and proved for stars, trees, and paths and their associated energy. For a matrix associated with the graph, the energy of a graph is defined as the sum of the absolute values of the eigenvalues.

Cofrin 15

MARK LEROY, Loras College
Complex Geometry

Complex numbers can be represented by points on a plane. So, we can consider the (complex) roots of polynomials as points on the plane. We look at the relationship between the geometric arrangement of those points, and the roots of the derivatives of the corresponding polynomials.

9:50- 10:05
Cofrin 11

MEGAN WISNIEWSKI, Benedictine University
Counting Hexagonal Knot Mosaics

Lomonaco and Kauffman have developed the concept of knot mosaics as part of their theory of quantum knots. A *knot mosaic* is a particular embedding of a knot diagram in a square grid. In this talk, we begin to explore the analogous notion of knot diagrams embedded in a hexagonal grid, which we call *hexagonal knot mosaics*. Specifically, we enumerate the hexagonal knot mosaics that can be constructed under some mild conditions

Cofrin 15

CAESAR CAI, St. Norbert College
Prime Number, Mersenne Number, and Mersenne Prime – Seeking the Largest Prime Number

I will talk about the definition of Prime Numbers and Mersenne Numbers, then give some history and recent news about Mersenne Numbers, and then present my work about Mersenne Numbers. Finally, I will show an application of large prime numbers on RSA public key cryptography

10:10 – 10:25
Cofrin 11

COREY VORLAND, St. Norbert College
Modeling Diatom Growth in Trout Lake, Part 2

Aulacoseira is a freshwater diatom which forms log-like colonies. *Aulacoseiras*’ growth is determined by a complex, interconnected relationship between mixing and light availability in the lake. Mixing, generated by turbulent convection, alters the location of *Aulacoseira* within the depth of the lake, consequently altering its ability to obtain light for growth. *Aulacoseira*’s abundance and colony size have been measured at varying depths in Trout Lake in Northern Wisconsin. In previous work, we built a mathematical model which accounted for growth and sinking of the diatom. However, sinking was only qualitatively included. In this work, the model takes a more quantitative approach to including the diatoms’ sinking velocity, which is not well known in the

biological field. This work is in collaboration with Stephanie Schauer, another undergraduate student at St. Norbert College.

Cofrin 15

BEN KOERNER, UW – Stout
Mathematics behind RSA Encryption

RSA (Rivest, Shamir and Adleman who first publicly described it) is an algorithm for public-key cryptography. It is the first algorithm known to be suitable for signing as well as encryption. RSA is widely used in electronic commerce protocols and it is believed to be secure, given sufficiently long keys and the use of up-to-date implementation. The mathematics behind RSA encryption and why it is a secure encryption algorithm will be discussed. Key size and NP-Complete will also be discussed.

10:30 - 10:45

Cofrin 11

PINAL SHAH, Benedictine University
The Dynamics of One-Predator Two-Prey Models for Integrated Pest Management

We present several variations of one-predator two-prey models for integrated pest management. Features of these models include stage structure for the predator species and one of the prey species and a birth pulse (rather than continuous growth) for the stage structured prey species. We demonstrate the existence of total pest eradication solutions and permanent solutions.

Cofrin 15

SERGII S. BILOKHATNIUK, St. Norbert College
Gödel's Incompleteness Theorem and Artificial Intelligence

Gödel's incompleteness theorem (GIT) shows inconsistency (or incompleteness) of all formal systems that incorporate a certain amount of theory of natural numbers. Since there is no universal algorithm to produce Gödel numbers for every formal system, contemporary computers, built and functioning as formal systems themselves, are incapable to generate Gödel numbers as humans do, without preprogramming. Gödel's inconsistency theorem can be used as contra-argument for AI's ability to achieve human-like intelligence, but some theoretical solutions for the problem are also proposed.

11:00 - 12:00

Cofrin 11

Invited Address: **DAN KALMAN, American University**

Provincial Polynomia: Uncommon Excursions for the Seasoned Visitor

This talk is for long time friends of Polynomia, who have wandered its pathways many times. I will guide the audience to some out of the way destinations that are easily accessible from the most well traveled and familiar thoroughfares of the realm. Such destinations show that Polynomia still has much to surprise, delight, and intrigue even the most seasoned visitors. The itinerary includes Horner evaluation, Lill's method, the curly-root function, and Marden's Theorem.

DAN KALMAN has been writing about and teaching mathematics for 30 years. A graduate of Harvey Mudd College (BS, 1974) and the University of Wisconsin (PhD, 1980) he is a Professor of Mathematics at American University, Washington, DC. He previously held faculty positions at the University of Wisconsin, Green Bay, and Augustana College, Sioux Falls, among other institutions, and worked for several years as an applied mathematician at the Aerospace Corporation. He also served for one year as an Associate Executive Director of the MAA.

Kalman has been an invited speaker at numerous national and regional mathematics conferences (one of the first of which was the NE Wisconsin Math Seminar at St. Norbert College in fall, 1981), and has spoken to student clubs and PME chapters many times. His mathematical writing has been recognized with multiple MAA awards: Allendoerfer Awards in 1998 and 2002, Polya Awards in 1994 and 2002, an Evans Award in 1997, and the Lester R. Ford Award in 2009. He is the author of two books published by the MAA. Kalman has served on the Editorial Boards for several MAA publications, including *Mathematics Magazine*, *FOCUS*, *Math Horizons*, and the *Spectrum and Classroom Resource Materials* book series.

**INVITED SPEAKERS FOR THE
ST. NORBERT COLLEGE PI MU EPSILON
REGIONAL UNDERGRADUATE MATHEMATICS CONFERENCES**

1986 Paul Campbell, Beloit College
1987 Joseph Gallian, University of Minnesota - Duluth
1988 Philip Straffin, Beloit College
1989 J. Sutherland Frame, Michigan State University
1990 Jeanne LaDuke, De Paul University
1991 J. Douglas Faires, Youngstown State University
1992 James Kasum, Cardinal Stritch College
1993 Mark Krusemeyer, Carleton College
1994 Robert S. Smith, Miami University
1995 Norbert J. Kuenzi, UW - Oshkosh
1996 Donald Saari, Northwestern University
1997 Paul J. Humke, St. Olaf College
1998 I. Martin Isaacs, UW - Madison
1999 Lisa Townsley Kulich, Benedictine University
2000 S. Brent Morris, National Security Agency
2001 Aparna Higgins, University of Dayton
2002 Frank Morgan, Williams College
2003 Richard A. Brualdi, UW – Madison
2004 Erica Flapan, Pomona College
2005 Alexander Hahn, The University of Notre Dame
2006 Underwood Dudley, Tallahassee, Florida
2007 Keith Devlin, Stanford University
2008 Eve Torrence, Randolph-Macon College
2009 Dan Kalman, American University

WINNERS OF THE REV. NICHOLAS E. NIRSCHL SCHOLARSHIPS

1996 Dawn Gibson, Jacqueline Gosz, Sarah Nohr, Nicki Schleis, Dennis Schmidt
1997 Debbie Giesler, Tina Huss, Mark Meeker
1998 Laura Lemke, Jenny Schmidt, Libby Wiebel
1999 Renee Jonet, Erica Pagel, Kate Rendall
2000 Michelle Budzban, Danielle Delimata, Heather Olm, Rosemary Tomase, Jeremy Vosters
2001 Cinnamon Danube, Abby Mroczenski, Laura Weiland
2002 Erin M. Bergman
2003 Tammy Bastian, Rachel Meulemans, Jill Schmidt
2004 Adam Christman, Brian Hahn, John Karls, Monica Spang, Damian Wegner
2005 Josh Domina, Christy Ernst, Mike Konicki, Martina Weber, Angie Wille, and AJ Wood
2006 Trina Bower, John Moss, Nicole O'Connell, Jackie Van Ryzin
2007 Elizabeth Colletti, Mark Krines, Sarah Schultz
2008 Francis Beaumier, Kyle Diederich, Jenni Jacobsen, Ryan Pavlik
2009 Brice Hilgemann, Michelle Keehan, Kathleen Miller, Stephanie Schauer, Adam Ziegler