ABSTRACTS

Scott Ahlgren, Colgate University
3:30-3:50PM, SATURDAY, NOVEMBER 13
Gaussian Hypergeometric Series, Elliptic Curves, and Combinatorial Congruences
Gaussian hypergeometric series were first introduced by J. Greene as finite field analogues of classical hypergeometric series. Recent works have shown that special values of these series are connected to much of number theoretic and combinatorial interest. In a recent paper, for example, Ken Ono and I uncover such connections involving modular forms, p-adic analysis, and the Wilf-Zeilberger identity proving method; these connections yield a proof of one of Beukers' "supercongruence" conjectures for the Apery numbers. In this talk I will discuss similar phenomena involving other families of Gaussian hypergeometric series and the elliptic curves and combinatorial congruences to which they are related. In particular, I will show how these connections lead to a proof of another of Beukers' supercongruence conjectures.

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George Andrews, Pennsylvania State University
9:10-10:00AM, THURSDAY, NOVEMBER 11
Search Algorithms in the Study of q-Series
We begin the talk with an account of some of the algorithms that have been used in the study of partitions and q-series. We begin with the Euler-Ostmann algorithm. Following this history we shall describe recent work (with Arnold Knopfmacher, the late John Knopfmacher and Peter Paule) on the generalized Engel algorithm. Engel developed an expansion for real numbers which provided a means of testing for irrationality. The Knopfmachers extended this method to the theory of analytic functions. We shall show how it can be used to "discover," as well as prove, results like the Rogers-Ramanujan identities. We close with some discussion of possible extensions of this algorithm.

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Alexander Berkovich, University of Florida
10:30-10:50AM, THURSDAY, NOVEMBER 11
A Double Bounded Key Identity for Göllnitz' (big) Partition Theorem
Perhaps, one of the deepest results in the theory of partitions is Göllnitz' theorem (1967). Recently, Alladi, Andrews and Gordon refined this theorem and showed that it emerges out of, so called, identity for q-hypergeometric series. In my talk, I, first, give a straight forward interpretation of this identity and then, propose and prove its double bounded terminating analog. This new formula can be viewed as a one parameter extension of the famous Dougall ${}_6\phi_5$ summation formula. Finally, I briefly discuss possible ways to go beyond Göllnitz theorem.

Bruce Berndt, University of Illinois
11:10-11:30AM, FRIDAY, NOVEMBER 12
On the Transformation Formula for the Dedekind Eta-Function
(with K. Venkatachaliengar)
A new simple proof of the transformation formula for the Dedekind eta-function is given. Some connections with certain infinite series are made.

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David Bradley, University of Maine
3:00-3:20PM, SATURDAY, NOVEMBER 13
Resolution of Some Open Problems Concerning Multiple Zeta Evaluations of Arbitrary Depth
Some new evaluations for multiple polylogarithms of arbitary depth, including evaluations for certain alternating unit Euler sums are given. The simplest of these results is a multiple zeta evaluation one order of complexity beyond the well-known Broadhurst-Zagier formula. A proof of what was until recently one of the few remaining outstanding conjectures in the Borwein-Bradley-Broadhurst compendium is also given.

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John Brillhart, University of Arizona
4:40-5:00PM, SATURDAY, NOVEMBER 13
Reverting the Power Series for Real Elliptic Integrals of the First Kind
If we are given the power series of a function f, it is rarely possible to find the general term of the power series of f^{-1} in a usable form. Usually we have to settle for the coefficients only up to some specific degree.
In this talk we will find the Maclaurin expansion for f^{-1} when the f series is that of any real elliptic integral of the first kind. The general formula obtained will then be used to prove some periodic divisibility results for the coefficients of the series for f^{-1}.

Heng-Huat Chan, National University of Singapore
11:40-12:00, FRIDAY, NOVEMBER 12
A New Class of Series for $\frac{1}{\pi}$
Let $f(-q)=\prod_{k=1}^{\infty}(1-q^k), |q|<1$. On page 212 of his Lost Notebook, S. Ramanujan defined the function

$$\lambda_n = \frac{e^{\pi/2\sqrt{n/3}}}{3\sqrt{3}}\frac{f^6(e^{-\pi\sqrt{n/3}})}{f^6(e^{-\pi\sqrt{3n}})}$$

and recorded its values for $n = 1, 9, 17, 25, 33, 41, 49, 73, 97$, and 121. The proofs of these evaluations have recently been given by B.C. Berndt, S.Y. Kang, L.C. Zhang and the author. In this talk, I will show how the known values of λ_n can be used to establish new series for $\frac{1}{\pi}$. An example of such a series, in the case when $n = 9$, is

$$\frac{4}{\pi\sqrt{3}} = \sum_{k=0}^{\infty}(5k+1)\frac{\left(\frac{1}{3}\right)_k\left(\frac{2}{3}\right)_k\left(\frac{1}{2}\right)_k}{(1)_k^3}\left(-\frac{9}{16}\right)^k,$$

where $(a)_k = (a)(a+1)(a+2)\cdots(a+k-1)$.

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Youn-Seo Choi, Korean Advanced Institute of Science and Technology, Seoul
12:00-12:20, THURSDAY, NOVEMBER 11
Two Identities for Tenth Order Mock Theta Functions in Ramanujan's Lost Notebook
Ramanujan's lost notebook contains eight tenth order mock theta function identities. It is the purpose of this talk to provide the sketch of proofs of the fifth and sixth identities among Ramanujan's tenth order mock theta function identities.

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David and Gregory Chudnovsky, Polytechnic University
[Talk to be delivered by **Mourad Ismail**]
4:10-4:30PM, SATURDAY, NOVEMBER 13
Orthogonal Polynomials and the Solution of the Pulse Width Modulation Problem
It is shown how orthogonal polynomials and solitons lead to the solution of the pulse width modulation problem of accurately representing a harmonic wave using only square forms of fixed height.

Charles Dunkl, University of Virginia
10:10-10:30AM, SATURDAY, NOVEMBER 13
Orthogonal Polynomials of Types A and B and Computer Algebra Assistance
Formulas for orthogonal polynomials of several variables can be elusive and hard to discover. We discuss the situation of polynomials associated with the symmetric groups and the hyperoctahedral groups, the Weyl groups of type A and B respectively. With the use of the computer algebra system Maple, we can search for interesting formulas and equations and be led to plausible conjectures. Examples from the theories of nonsymmetric Jack polynomials and generalized harmonic polynomials will be presented.

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Dennis Eichhorn, University of Arizona
3:00-3:20PM, THURSDAY, NOVEMBER 11
On the Divisibility of $r_k(n)$, the Number of Representations of n as a Sum of k Squares
In some recent work by the speaker, a technique for proving congruences for $r_k(n)$ in arithmetic progressions is developed. In particular, an explicit constant C is produced such that if a congruence of the form $r_k(hn + r) \equiv 0 \pmod{m}$ holds for all $n \leq C$, then the congruence must hold for all n. This follows from some elementary properties of modular forms. Bateman has now given an elementary proof of a slightly stronger version of certain cases of this theorem, and in doing so, he has shown that in some instances, the constant C produced using the former technique is best possible. In this talk, we discuss these two new insights into $r_k(n)$.

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Ira Gessel, Brandeis University
11:10-11:30AM, SATURDAY, NOVEMBER 13
WZ Forms and Hypergeometric Summation Formulas
The WZ method of Wilf and Zeilberger is a well known technique for proving hypergeometric summation formulas. It can also be used to find new summation formulas from old by duality. However, one identity many have many different duals. WZ forms, introduced by Zeilberger in 1993, give a way of systematizing this use of duality, and of unifying many apparently different identities.

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Robert Gustafson, Texas A & M University
10:40-11:00AM, SATURDAY, NOVEMBER 13
Rational Symmetric Functions on BC_n
We discuss a new kind of symmetric function associated to the root system BC_n generalizing a number of previous functions such as Schur, Macdonald, Biedenharn and Okounkov. These functions have a number of important properties including analogues of Cauchy identity, Weyl dimension formula, location of zeroes an poles. They also occur in remarkable multivariate q-series identities generalizing classical well-poised summation and transformation theorems.

Marvin Knopp, Temple University
3:40-4:00PM, THURSDAY, NOVEMBER 11
Sums of Squares and the SMUCR's Principle
Let $s \in \mathbb{Z}^+$, m a nonnegative integer and let $r_s(m)$ be the number of ways to represent m as a sum of squares. Let $r_s^*(m)$ be the number of ways to represent m as a sum of odd squares. Then $r_s^*(m) = 0$ unless $m = 8n + s$, with n a nonnegative integer. In [Ramanujan J. 2 (1998)] Paul Bateman and MK showed in an elementary manner that for $1 \le s \le 7$,

$$r_s(8n+s) = \{1 + \frac{1}{2}\binom{s}{4}\}\, r_s^*(8n+s),$$

for all $n \ge 0$. Furthermore, for $s \ge 8$, the ratio

$$r_s(8n+s)/r_s^*(8n+s)$$

remains bounded as $n \to \infty$.
The authors show here that when $s \ge 8$ the ratio is not constant, not even for sufficiently large n. The proof depends heavily upon an instance of the principle:
Survival of Modularity Under Congruence Restrictions:
Let $f(z) = \sum_{n=n_0}^{\infty} a(n) e^{2\pi i n z}$ be a modular form of weight k on a congruence subgroup Γ of SL$(2, Z)$. For α, $\beta \in \mathbb{Z}$ define

$$f(z; \alpha, \beta) = \sum_{n=n0 n\equiv\alpha \pmod{\beta}}^{\infty} a(n) e^{2\pi i n z}.$$

Then, $f(z; \alpha, \beta)$ is a modular form of weight k on some congruence subgroup Γ' of Γ. The level of Γ' depends upon β and the level of Γ.
The reader is alerted that the principle is a theorem only when suitable restrictions upon k and the multiplier system of $f(z)$. In the application here $f(z) = \vartheta(2z)^s$, the generating function for $r_s(m)$, so $k = s/2$ and the multiplier system is expressed in terms of the Jacobi symbol.

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Wolfram Koepf, HTWK, Leipzig
4:00-4:20PM, FRIDAY, NOVEMBER 12
A Maple Package on q-Hypergeometric Summation

Basic or *q-hypergeometric series* are power series $\sum_{k=0}^{\infty} A_k\, x^k$ whose coefficients A_k have a term ratio $A_{k+1}/A_k \in \mathbb{Q}(q^k)$ which is rational w.r.t. q^k. Such coefficients A_k are called *q-hypergeometric terms*. The q-analog of the celebrated *Gosper algorithm* decides whether a q-hypergeometric term a_k has a q-hypergeometric term *antidifference* s_k, i.e.

$$a_k = s_{k+1} - s_k$$

and computes it in the affirmative case. In this case, summation is trivial

$$\sum_{k=u}^{v} a_k = a_{v+1} - a_u \ .$$

The q-analog of *Zeilberger's algorithm* finds a recurrence equation for a q-hypergeometric series

$$S(n) = \sum_{k\in\mathbb{Z}} F(n,k)$$

s.th. $F(n,k)$ is a q-hypergeometric term with respect to both n and k. This recurrence equation is *q-holonomic*, i.e., it is linear, homogeneous, and has polynomial coefficients w.r.t. q^n.
Finally, the q-analog of *Petkovesek's algorithm* finds q-hypergeometric term solutions of q-holonomic recurrence equations.
The theory of hypergeometric and q-hypergeometric series as well as the above algorithms are developed in [2].
In this talk, I present a Maple package, jointly developed with Harald Böing [1], which deals with these three and some more algorithms. Many applications, in particular to orthogonal polynomials and special functions, are given.

References

[1] Böing, Harald and Koepf, Wolfram: Algorithms for q-hypergeometric Summation in Computer Algebra. Konrad-Zuse-Zentrum Berlin (ZIB), Preprint SC 98–02, 1998, to appear in: Journal Symbolic Computation, 1999.

[2] Koepf, Wolfram: *Hypergeometric Summation. An Algorithmic Approach to Summation and Special Function Identities.* Vieweg, Braunschweig/Wiesbaden, 1998, ISBN 3-528-06950-3.

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Christian Krattenthaler, Vienna University
11:00-11:20AM, THURSDAY, NOVEMBER 11
Variations of a Determinant By Andrews and Enumeration of Plane Partitions and Rhombus Tilings
The "stars" of my talk will be the determinants

$$\det_{0\leq i,j\leq n}(\omega\delta_{ij}+\binom{m+i+j}{j}),$$

where ω is any sixth root of unity. When $\omega = 1$ this is a famous determinant: It was evaluated by George Andrews thus proving the (at that time) conjectured formula for the number of cyclically symmetric plane partitions. In my talk, I will explain the combinatorial significance of these determinants. They arise in enumeration problems on plane partitions posed by Stembridge and in the enumeration of rhombus tilings of a hexagon with a triangle removed from its centre. I will demonstrate how these determinants can be evaluated, thus solving the aforementioned enumeration problems.

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Richard Lewis, Sussex University
11:40-12:00, SATURDAY, NOVEMBER 13
An Identity Relating a Theta Function and a Sum of Lambert Series
I will state and prove the identity of the title and discuss applications to sums of squares.

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Zhi-Guo Liu, Xinxiang Education College, P.R. China
5:00-5:20PM, FRIDAY, NOVEMBER 12
Some Eisenstein Series Identities Associated with the Borweins' Functions
In this note, we will derive some Eisentein series identities associated with the Borweins functions based on a well-known identity involving theta-functions and the method of logarithmic differentiation. We will derive some theta-function identities involving the Borwein functions by employing the theory of elliptic functions. From these theta-function identities we give different approachs to the Eisenstein series identities involving the Borweins function. By using some Eisentein series identities of this note, we provide completely new proofs of the Borweins' cubic theta function identity and the well-known Jacobi identity in the theory of modular forms.

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Jeremy Lovejoy, Pennsylvania State University
4:45-5:00PM, THURSDAY, NOVEMBER 11
Divisibility and Distribution of Partitions into Distinct Parts
Let $Q(n)$ denote the number of partitions of n into distinct parts. For any prime p larger than 3 and any residue class r modulo p I will address the following question: How often is $Q(n)$ congruent to r modulo p? Applying the theory of modular forms leads to some interesting and rather unexpected answers.

Barry McCoy, Institute for Theoretical Physics, Stony Brook
9:00-9:50AM, FRIDAY, NOVEMBER 12
Rogers-Ramanujan Identities in Statistical Mechanics and Conformal Field Theory
The fundamantal role which Rogers-Ramanujan identities play in both statistical mechanics and conformal field theory will be presented. The subject is currently in a rapid state of developement and the present status and outstanding problems will be discussed including the role of algebra versus analysis in physics.

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Richard McIntosh, University of Regina
11:30-11:50, THURSDAY, NOVEMBER 11
An Infinite Family of Mock Theta Functions
We construct a one parameter infinite family of mock theta functions with a complete set of transformation formulas under the action of the modular group. This family includes most of Ramanujan's third order mock theta functions and is connected to his fifth and seventh order mock theta functions by formulas of Dean Hickerson. The transformation formulas for the third order functions were obtained by G.N. Watson. We give explicit transformation formulas for the fifth and seventh order functions.

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Steve Milne, Ohio State University
9:40-10:00AM, SATURDAY, NOVEMBER 13
Some New Infinite Families of Eta Function Identities (joint with Verne E. Leininger)

Ever since Euler proved his expansion for $\prod_{i=1}^{\infty}(1-q^i) \equiv (q;q)_\infty$ mathematicians have been looking for other identities of this form. In 1829, Jacobi utilized his triple product identity to derive an elegant expansion for $(q;q)_\infty^3$. Since then, expansions have been found for $(q;q)_\infty^c$ for many values of c. These included several infinite families of expansions and a few exceptional cases. In 1892 F. Klein and R. Fricke gave a result for $c = 8$. This was rediscovered by S. Ramanujan in 1916. L. Winquist in 1969 proved a result for $c = 10$ but stated that this was first found by J. Rushforth, then independently discovered by A. Atkin. L. Winquist also noted that A. Atkin had formulae for $c = 14$ and $c = 26$. The existence of these identities had been suggested in 1955 by M. Newman. In 1972 F. Dyson gave his famous formula for $c = 24$ and stated that formulae corresponding to $c = 3, 8, 10, 14, 15, 21, 24, 26, 28, 35, 36, \ldots$ had been found, but noted that these ad hoc results had been unified by I. Macdonald. In his landmark 1972 paper, Macdonald related most of these expansions for $(q;q)_\infty^c$ to affine root systems. (This connection with Lie Algebras has been the main focus of work since I. Macdonald.) A few notable exceptions remained: $c = 2$ found by Hecke and Rogers, $c = 4$ by Ramanujan, and $c = 26$ by Atkin.

In this talk we discuss our derivation of new, more symmetrical expansions for $(q;q)_\infty^{n^2+2n}$ by means of our multivariable generalization of Andrews' variation of the standard proof of Jacobi's $(q;q)_\infty^3$ result. We also present examples of our general expansion for $(q;q)_\infty^c$ where $c = 3, 8, 15, 24$. Our proof relies upon Milne's new $U(n)$ multivariable extension of the Jacobi triple product identity. This result is deduced from a $U(n)$ multiple basic hypergeometric series generalization of Watson's very–well–poised ${}_8\phi_7$ transformation. The derivation of our $(q;q)_\infty^{n^2+2n}$ expansion also utilizes partial derivatives and dihedral group symmetries to write the sum over regions in n-space. We note that our expansions for $(q;q)_\infty^{n^2+2n}$ are equivalent to Macdonald's A_n family of eta-function identities. In addition, we utilize various summation and transformation formulas for $U(n+1)$, equivalently A_n, multiple basic hypergeometric series to derive new infinite families of expansions for $(q;q)_\infty^{n^2+2}$ and $(q;q)_\infty^{n^2}$, similar products of these, and the corresponding powers of the η-function. (Recall that the eta function is defined by $\eta(q) := q^{1/24}(q;q)_\infty$.) These additional infinite families of expansions extend the list in Appendix I of Macdonald's 1972 paper. All of this work is motivated by Milne's $U(n+1)$ multiple basic hypergeometric series treatment of the Macdonald identities for $A_\ell^{(1)}$.

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Maki Murata, Pennsylvania State University
4:05-4:20PM, THURSDAY, NOVEMBER 11
Modularity of Certain $K3$-surfaces
I'll give an elementary proof for showing the modularity of three particular $K3$-surfaces studied by F. Beukers and J. Steinstra in their paper. In the proof, q-series identities and some character sums take crucial roles.

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K.A. Muttalib, University of Florida
10:40-11:00AM, FRIDAY, NOVEMBER 12
q-polynomials in Random Matrix Theory and the Physics of Multifractality
A wide variety of quantum systems (like complex nuclei, atoms and molecules, small disordered metals as well as quantum systems whose classical counterparts are chaotic) share some generic statistical properties of energy levels. These properties can be understood most naturally in terms of the stochastic and symmetry properties of the Gaussian Random Matrix Ensembles (RMEs). In this talk I will briefly review how the well known universal (zero parameter) limits of the Gaussian RMEs follow from certain double scaling limits of classical orthogonal polynomials. I will then discuss a new class of RMEs based on the q-orthogonal polynomials which describes the generic statistical properties of quantum systems in the 'critical' regime when the system undergoes a phase transition from the chaotic to an integrable state. As an example, I will consider the metal to insulator transition in disordered electronic systems, where this new class of RMEs describe the expected 'multifractal' wavefunctions associated with the critical regime.

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Ken Ono, Pennsylvania State University and the University of Wisconsin at Madison
2:00-2:50PM, THURSDAY, NOVEMBER 11
Congruences for $p(n)$ and Some Questions of Serre on the Fourier Coefficients of Modular Forms
In this talk I will describe some recent work regarding the behavior of coefficients of modular forms. In particular, I will describe new results on the distribution of the partition function modulo primes $M > 3$, and I will announce solutions to some longstanding questions of Serre on the paucity of zero coefficients for generic modular forms.

Peter Paule, RISC, Linz
3:00-3:20PM, FRIDAY, NOVEMBER 12
Algorithmic Aspects of q-hypergeometric Summation
WZ-theory has prepared the grounds for an algorithmic treatment of q-hyper-geometric summation. The talk highlights computational aspects that are relevant not only for automatic proving but also for heuristic investigation. For instance, we discuss: the production of recurrences under order-constraints, order reduction by "creative symmetrizing", qWZ-duality, Bailey-chains, multi-basic summation, and q-multisums. Corresponding algorithmic tools have been implemented by Axel Riese who will present his Mathematica packages in form of a software demo.

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Thomas Prellberg, Syracuse University
10:10-10:30AM, FRIDAY, NOVEMBER 12
Partition Function Asymptotics for Two-dimensional Lattice Vesicles
Closed fluctuating membranes, or vesicles, can be modeled in two dimensions by self-avoiding polygons on the square lattice.
We derive the dominant asymptotic form and the order of the correction terms of the finite-perimeter partition function of self-avoiding polygons on the square lattice, which are weighted according to their area A as q^A.

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Axel Riese, RISC, Linz
3:25-3:40PM, FRIDAY, NOVEMBER 12
Treating q-Identities with the Computer
The q-Zeilberger algorithm has become a standard tool for automatically proving q-hypergeometric identities. We shall demonstrate an extended version of this algorithm written in Mathematica. This package comes along with many extra features that assist the q-hypergeometric work. Moreover, we introduce a prototype for the treatment of q-hypergeometric multi-sums, a bibasic generalization of Gosper's algorithm, and a package for automatically walking along Bailey chains.

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Dennis Stanton, University of Minnesota
2:00-2:50PM, SATURDAY, NOVEMBER 13
Open Problems in q-series
I will present some open problems in q-series that should be successfully attacked by symbolic methods. These include:

1. a polynomial version of a quintic transformation implying the RR identities
2. positivity conjectures for generalized q-multinomial polynomials
3. positivity conjectures for restricted integer partitions

M.V. Subbarao, University of Alberta
4:30-4:50PM, FRIDAY, NOVEMBER 12
Remarks on Certain Product Expansions
We obtain apparently new expansion formulae for

$$\sum_{n=1}^{\infty} a^h q^{h(n+1)} \prod_{i=1}^{n} \left(\frac{1+aq^i}{1+bq^i} \right)$$

and

$$\sum_{n=1}^{\infty} b^h q^{h(n+1)} \prod_{i=1}^{n} \left(\frac{1-aq^i}{1-bq^i} \right)$$

where $h = 1, 2, 3, \ldots$ which generalize earlier results of Eden and Andrews, Subbarao and Vidyasagar. We also consider some other products and related conjectures.

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Sergei Suslov, Arizona State University
8:30-9:20AM, SATURDAY, NOVEMBER 13
Basic Fourier Series: Introduction, Analytic and Numerical Investigation
The study of Fourier series has a long and distinguished history in mathematics. They were introduced in order to solve the heat equation, and since then they have been frequently used in various applied problems. Much of modern real analysis including Lebesgue's fundamental theory of integration had its origin in some deep convergence questions in Fourier series. An interesting extension of Fourier series was discovered recently. In this talk we intend to lay a sound foundation for this study. We introduce basic Fourier series, investigate their main properties, and discuss some applications. We discuss also several computational aspects of basic Fourier series. Interesting open problems and further extensions of the theory will be given.

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Rhiannon Weaver, Pennsylvania State University
4:25-4:40PM, THURSDAY, NOVEMBER 11
New Congruences for the Partition Function
Let $p(n)$ be the number of unrestricted partitions of a non-negative integer n. Ramanujan proved for all $n \geq 0$ that

$$p(5n+4) \equiv 0 \pmod{5}, \tag{1}$$
$$p(7n+5) \equiv 0 \pmod{7}, \tag{2}$$
$$p(lln+6) \equiv 0 \pmod{11}. \tag{3}$$

Recently, Ono proved for every prime ≥ 5 that there exist infinitely many congruences of the type $p(An+B) \equiv 0 \pmod{m}$. However, his results are theoretical and do not lead to an effective algorithm for finding such congruences. Here we obtain such an algorithm for primes $13 \leq m \leq 31$ which reveals 70,266 new congruences.

Doron Zeilberger, Temple University
2:00-2:50PM, FRIDAY, NOVEMBER 12
A Tutorial on Mint: Akalu Tefera's Brilliant Fully-Automated Implementation of the Continuous Multi-WZ Method
Akalu Tefera's recent powerful and efficient implementation of the continuous multi-WZ method will be discussed and (hopefully) demonstrated. The q-analog, qMint, currently under construction, will also be mentioned.

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Liang-Chang Zhang, Southwest Missouri State University
5:10-5:30PM, SATURDAY, NOVEMBER 13
Explicit Evaluation of a Ramanujan-Selbeg Continued Fraction
We use modular equations and class invariants to evaluate a Ramanujan-Selberg continued fraction.

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