Schedule of talks.

Thursday (April 9)
Morning session

9:30-10:20

Alexander Barvinok (University of Michigan)

Complex geometry and computational complexity of the permanent

Abstract. The permanent of a square matrix is defined almost like the determinant, only simpler: all monomials are counted with the "+" sign. Permanents of 0-1 matrices are of interest to combinatorics as they enumerate perfect matchings in bipartite graphs and permanents of complex matrices are of interest in physics as they "enumerate" bosons. We prove that the permanent of an nxn complex matrix is never 0 provided all the entries of the matrix are within distance 0.275 from 1 (the exact value of the constant is not known, though one cannot replace 0.275 by 0.710, say). Consequently, the permanent of an nxn complex matrix can be computed within a relative error epsilon in quasi-polynomial $n^{O(\ln n - \ln \epsilon)}$ time provided all the matrix entries are within distance 0.274 from 1. The method is readily extended to hafnians, multi-dimensional permanents and other partition functions.

Thursday (April 9)
Morning session

10:35-11:25

Peter Dragnev (Indiana University – Purdue University Fort Wayne)

with P. Boyvalenkov, D. Hardin, E. Saff, M. Stoyanova

Delsarte-Yudin LP method and universal lower bounds on energy

Abstract. We derive universal lower bounds for the potential energy of spherical codes, that are optimal in the framework of Delsarte's linear programming approach adapted for energy bounds by Yudin. Our bounds are universal in the sense of both Levenshtein and Cohn and Kumar; i.e., they are valid for any choice of dimension and code cardinality and that they apply to any absolutely monotone potential.

Thursday (April 9)
Morning session

11:40-12:30

Achill Schürmann (University of Rostock)

Exploiting symmetries of lattice polytopes

Abstract. Exploiting symmetry in integer linear programming and lattice point counting are two difficult problems for which no good general approach exists. In fact, standard techniques work particularly poor on symmetric problems. In this talk we give an overview about ongoing work on new symmetry exploiting techniques for these two fundamental problem classes involving lattice polytopes. We in particular present some new ideas of decomposing lattice polytopes and give some initial proof-of-concept results, applying these new techniques.

Thursday (April 9)
Afternoon session

2:20-3:10

Robert Connelly (Cornell University)

Sticky sphere packings

Abstract. Suppose a finite packing of equal spheres in 3-space is such that any pair of touching spheres is forced to remain in contact. When is such a configuration rigid? In some cases the configuration is under constrained and often it is over constrained. One natural notion of rigidity is prestress stability, and there are some techniques for calculating that rigidity.

Thursday (April 9)
Afternoon session

3:25-4:15

Włodzimierz Kuperberg (Auburn University)

with András Bezdek

Approximating convex disks from inside and out by parallelograms

Abstract. For each convex disk K we consider the minimum area $P(K)$ of a parallelogram containing K and the maximum area $p(K)$ of a parallelogram contained in K, then we seek the maximum of $P(K)$ and the minimum of $p(K)$ over all convex disks K of area 1. Without assuming central symmetry of K, the naturally anticipated answers are given, but when we assume central symmetry, the problem of the maximum of $P(K)$ becomes much harder. We state a conjecture and discuss it in a quite broad context that includes the well-known, still unresolved Reinhardt Conjecture on the criticality of the smoothed octagon.

Thursday (April 9)
Afternoon session

4:30-5:20

Hiroshi Nozaki (Aichi University of Education)

with Cioaba, Koolen, and Vermette

Dual relationship of regular graphs and spherical codes

Abstract. We will introduce some dual relationship between regular graphs and spherical codes. In this relationship, the distinct eigenvalues of a regular graph dually correspond to inner products of a spherical code. The spectral gap of a regular graph is the difference of the largest and second-largest eigenvalues. The spectral gap dually corresponds to the minimum distance of a spherical code. It is known that a graph with large spectral gap has high connectivity in some sense. We would like to find graphs with largest spectral gap for given degree and order, or largest graphs for given degree and second-largest eigenvalue. In this talk, we introduce several new results about the two problems.

Friday (April 10)
Morning session

9:30-10:20

Douglas Hardin (Vanderbilt University)

with Ed Saff, Brian Simanek and Yujian Su

Asymptotics of minimal discrete periodic energy problems

Abstract. Let L be a d-dimensional lattice in R^d. For a parameter $s > 0$, we consider the asymptotics of N point configurations minimizing the L-periodic Riesz s-energy as the number of points N goes to infinity. In particular, we focus on the case $0 < s < d$ of long-range potentials where we establish that the minimal energy $E_s(L, N)$ is of the form $E_s(L, N) = C_0 N^2 + C_1 N^{1+s/d} + o(N^{1+s/d})$ as $N \to \infty$. The constants C_0 and C_1 depend only on s, d, and covolume of the lattice L.

Friday (April 10)
Morning session

10:35-11:25

Igor Pak (University of California, Los Angeles)

with Danny Nguyen

Tiling spaces with congruent polyhedra

Abstract. A classical open problem going back to Fëdorov and Voronoy asks whether a polytope which tiles $\mathbb{R}^3$ can have an unbounded number of faces. Hilbert's 18th problem asks (in part) what polytopes arise as fundamental regions of group actions. I will give a selective survey of over a hundred years worth of progress on these problems and their variations, emphasizing tiling constructions in the spherical and the hyperbolic spaces. I will then present our new tiling constructions, notably of the neighborly spherical tilings.

Friday (April 10)
Morning session

11:40-12:30

Vladimir Tonchev (Michigan Technological University)

Incidence structures, codes, and Galois geometry

Abstract. The talk discusses a new invariant for finite incidence structures based on linear codes and Galois geometry, which has both an algebraic and a geometric description, and is motivated by the longstanding Hamada's conjecture about the minimum p-rank of the classical geometric designs. The new invariant was used recently in a joint work of the speaker with Dieter Jungnickel to prove a Hamada type characterization of the classical geometric designs having as blocks the d-subspaces of an n-dimensional projective or affine geometry over a finite field of order q.

Friday (April 10)
Afternoon session

2:20-3:10

Sergei Tabachnikov (Penn State and Brown University)

with M. Arnold, D. Fuchs, I. Izmestiev, and E. Tsukerman

Iterating evolutes and involutes

Abstract. The evolute of a plane curve is the envelope of its normals; the involute is a converse construction: the evolute of an involute is the given curve. In this talk I shall discuss iterations of these two constructions, in the continuous and the discrete settings. In the latter case, one deals with polygons, and one considers two discrete analogs of the normals: the bisectors of the angles, and the perpendicular bisectors of the sides. The dynamics of these two constructions is very different.

Friday (April 10)
Afternoon session

3:25-4:15

András Bezdek (Auburn University and Renyi Institute of Math, Budapest)

On two geometric games

Abstract. TBA

Friday (April 10)
Afternoon session

4:30-5:20

Wiktor J. Mogilski (Univeristy of Wisconsin – Milwaukee)

The weighted Singer conjecture for Coxeter groups in dimensions three and four

Abstract. Associated to a Coxeter system (W, S) there is a contractible simplicial complex Σ called the Davis complex on which W acts properly and cocompactly by reflections. Given a positive real multiparameter $\mathbf{q}$, one can define the weighted L^2-(co)homology groups of Σ and associate to them a nonnegative real number called the weighted L^2-Betti number. Within the spectrum of weighted L^2-(co)homology, there is a conjecture of interest called the Weighted Singer Conjecture which was formulated in a 2007 paper of Davis–Dymara–Januszkiewicz–Okun. The conjecture claims that if Σ is an n-manifold (equivalently, the nerve of the corresponding Coxeter group is an $(n-1)$-sphere), then the weighted L^2-(co)homology groups of Σ vanish above dimension $\frac{n}{2}$ whenever $\mathbf{q} \leq \mathbf{1}$ (that is, all terms of the multiparameter $\mathbf{q}$ are real numbers less than or equal to 1). We present a proof of the conjecture in dimension three that encompasses all but nine Coxeter groups. Then, under some restrictions on the nerve of the Coxeter group, we obtain partial results whenever $n = 4$ (in particular, the conjecture holds for $n = 4$ if the nerve of the corresponding Coxeter group is a flag complex). We then extend our results in dimension four to prove a general version of the conjecture for the case where the nerve of the Coxeter group assumed to be a flag triangulation of a 3-manifold.

Saturday (April 11)
Morning session

9:00-9:50

James Keesling (University of Florida)

Some new approaches to the Hilbert-Smith Conjecture

Abstract. The Hilbert-Smith Conjecture states that if a compact group acts effectively on a manifold, then it is a Lie group. It is known that the conjecture is true for manifolds of dimensions one, two, and three. It is unknown for manifolds of any other dimension.

This conjecture is related to Hilbert's Fifth Problem and is the last unsolved vestige of that famous problem. This talk will cover some of the rich history involved with many exciting discoveries covering more than a century. We will also cover some recent developments in the continuing assault on this problem.

Saturday (April 11)
Morning session

10:05-10:55

Andrei Yu. Vesnin (Sobolev Institute of Mathematics, Novosibirsk)

with E. Fominykh, S. Garoufalidis, M. Goerner and V. Tarkaev

A census of tetrahedral hyperbolic manifolds

Abstract. We call a cusped hyperbolic 3-manifold tetrahedral if it can be decomposed into regular ideal tetrahedra. Simplest examples of tetrahedral manifolds are the Gieseking manifold and the figure-eight knot complement. We provide a census of all tetrahedral manifolds with at most 25 (orientable case) and 21 (non-orientable case) tetrahedra.

Saturday (April 11)
Morning session

11:10-12:00

Sergey Grigorian (The University of Texas - Pan American)

Octonion bundles and isometric G2-structures

Abstract. Any orientable 7-dimensional manifold that also admits a spin structure also admits a G2-structure, a special geometric structure that can be thought of as a 7-dimensional analog of the vector cross product. A G2-structure then also defines a Riemannian metric on the manifold. Given a fixed G2-structure, we will define an octonion bundle on the manifold, and will show how sections of this bundle define isometric G2-structures, which are G2-structures that correspond to the same Riemannian metric. Finally, we will define a Dirac operator on the octonion bundle and will show how it relates to the torsion of the G2-structure.

Saturday (April 11)
Morning session

12:15-1:05

Virgil Pierce (The University of Texas - Pan American)

Counting triangulations of surfaces with the partition function of the unitary ensembles of random matrices

Abstract. The generating function of polygonizations of oriented surfaces is a tau-function of the Toda lattice hierarchy, a classic example of a nonlinear integrable system. This result has been exploited to derive solutions to the enumertion problem of polygonizations partitioned by the genus of the surface for some special cases. We will discuss the recent results for triangulations an the limits of the method for further cases.