First Joint Meeting of the Canadian and Mexican Mathematical Societies

September 21st - 23rd, 2006

CIMAT, A.C., Guanajuato, Gto., México

Conference Schedule

First Joint Meeting of the Canadian and Mexican Mathematical Societies

Canadian Mathematical Society

SOCIEDAD MATEMÁTICA MEXICANA

CIMAT

Welcome!

In this first meeting of the mathematical societies of Canada and Mexico, it gives us great joy to encounter so many mathematicians, at CIMAT in Guanajuato, who have come to share their ideas on a wide diversity of interests. Indeed, this event will be centered on eleven different areas of mathematics that are cultivated in our countries, gathering almost 180 speakers assembled in special sessions. Moreover, we will also have a chance to enjoy six plenary lectures.

We thank all of you for your enthusiastic response to this event. It can only augur a fruitful and exciting mathematical interaction where old bonds will be renewed and many others will be established. It also makes us confident that this is but the first of many future joint efforts.

The Organizing Committees

Contents

General Information

Conference Office

All matters regarding the Joint Meeting will be handled at the Conference Office (CO on the map) located downstairs from the Auditorium.

Registration

Wednesday 20th from 16:00 to 20:00, near the restaurant area at Hotel La Abadía (note that Hotel La Abadía has two "connected" components. Registration and welcoming cocktail will take place in the southernmost section of the hotel).

Thursday 21st from 9:30-13:30 and 15:30-18:20, at CIMAT, at the Registration Desk located upstairs from the Auditorium.

Payments can be made in USD, Canadian Dlls., Pesos Mexicanos or with Credit Card (No American Express). Checks will not be accepted.

Medical Service

We count with an infirmary at CIMAT (I on the map), run by a certified nurse, that will give aid during the meeting; it is located near the south parking lot. In case of need, go directly or ask for help at the Conference Office (CO on the map).

E-mail Room

There will be available an E-mail Room (labeled @ on the map), located on level H, across from the Probability session room.

Transportation Service

For your convenience there will be free transportation between Hotel La Abadía and CIMAT stopping at Hotel Guanajuato. The bus will start at the parking lot of the Hotel La Abadía (north section), making a stop (3 mins. later) at the sports complex by Hotel Guanajuato and then dropping everybody at "La Garita" (100m from CIMAT).

General Information

Bus's Schedule

	Thursday	Friday	Saturday
Hotels to CIMAT	8:45, 8:55, 9:05 and 9:15 hs.	8:45, 8:55, 9:05 and 9:15 hs.	8:45, 8:55, 9:05 and 9:15 hs.
CIMAT to Hotels	13:30 and 13:45 hs.	13:50 and 14:05 hs.	14:00 and 14:15 hs.
Hotels to CIMAT	15:15, 15.25, 15:35 and 15:45 hs.	15:15, 15.25, 15:35 and 15:45 hs.	
CIMAT to Hotels	19:10 and 19:25 hs.	19:10 and 19:25 hs.	

Note: On Saturday there will be offered transportation from La Abadía to the Mexican Fiesta; buses will leave at 19:30 and 19:45 from the usual spot at La Abadía.

Social Activities

- **Complimentary Cocktail Party** on Wednesday September 20th from 20:30 to 22:30 at Hotel La Abadía.
- **Callejoneada:** A callejoneada is a stroll (at a very slow pace) through the alleys (callejones) in downtown Guanajuato accompanied by a group of musicians (a "estudiantina") and where all participants are given a flask of wine to sip while they are explained the stories of the alleys and listen to traditional songs. It usually lasts 75 minutes. PLEASE NOTICE: to participate in this activity you must purchase a ticket (at our registration desk) before Thursday evening. There will be a limited number of places available.
- **Mexican Fiesta:** Dinner, traditional music and dance. This will be our farewell party, taking place in the Jardín San Francisco of the Ex-Hacienda San Gabriel de Barrera from 20:00 up until 2:00 am. Tickets for the Mexican Fiesta will be available at the registration desk and must also be purchased before Thursday evening.

Where to eat

There are several places for lunch and dinner in the city. The following list may be helpful to locate a restaurant of your preference.

General Information

Restaurant	Type	Address	Price
Real de la esperanza	International	500m up the highway to Dolores Hidalgo (looks like a church)	$$$$
Rancho de en medio	Mexican	35 mins up the highway to Dolores Hidalgo; nice views	$$
De la Sierra	Mexican	20 mins up the highway to Dolores Hidalgo, in the town of Santa Rosa; nice views	$$
Casa del Conde de la Valenciana	International	Across from the Valenciana Plaza; beautiful patio; 7 min. walk from CIMAT	$$$$$
8 Reales	International	Behind the Valenciana Church; 7 min. walk from CIMAT	$$$$
Hacienda de Marfil	French	In the town of Marfil; 20 mins across town	$$$$$
Refugio Casa Colorada	International	On top of the hill, near Pípila; 20 mins. across town	$$$$$
Ciao Bella	Italian	Positos # 15 ; Downtown area	$$$$
Gallo Pitagórico	International	Constancia # 10-A Downtown area	$$$$
Hotel Guanajuato	International	One of our bus's stops	$$$
Hotel la Abadía	Mexican and International	Main Hotel of the event	$$$
Hotel Castillo Santa Cecilia	Mexican and International	Across from La Abadía	$$$
Jardín de los Milagros	International	Across from La Abadía on Alhóndiga's street	$$$
Fast Food	Centro Comercial San Javier	Chinese and burgers; desserts Plaza San Javier, across the street from La Abadía (Northern section) and Castillo Santa Cecilia	$ or $$
El Truco 7	Mexican	Truco 7, downtown, behind the Cathedral	$
Casa Valadez	Mexican	Jardín Unión. Downtown area	$$$
Zopilote	International	Subida Principal; behind Teatro Principal in downtown	$$
El Retiro	Mexican	Calle Sopeña # 12, downtown area	$$$
Tasca de la Paz	International	Plaza de la paz, in front of the Cathedral	$$$

Prices: $n\$ \sim 5n$ USD.

General Information

Bar	Location
Cava Virreyes	Hotel La Abadía
El Consulado	Downtown
La Capellina	Downtown
Rincón de los Sabores	San Javier District, 50 meters from La Abadía
Bar Luna	Jardín Unión, Downtown
Santa fe	Jardín Unión, Downtown
Dama de las Camelias	Downtown

Committees and Sponsors

Scientific Committee

CMS: Alejandro Adem (Chair / Président), Walter Craig, Andrew Granville
SMM: J. C. Gómez Larrañaga (Chair / Président), Fernando Brambila, Lourdes Palacios

Local Organizing Committee

Luis Hernández-Lamoneda (Chair / Président)
Hernán González-Aguilar
Olivia Lazcano-Abarca
Víctor Núñez-Hernández
David Rivera-Caballero

Sponsors

Canadian Mathematical Society
Centro de Investigación en Matemáticas
Consejo de Ciencia y Tecnología del Estado de Guanajuato
Sociedad Matemática Mexicana
Subsecretaría de Educación Superior de la Secretaría de Educación Pública

General Schedule

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9:30 - 10:20</td><td rowspan="2">J. Urrutia
9:30 - 10:20</td></tr>
<tr><td rowspan="2">F. González Acuña
10:00 - 10:50</td></tr>
<tr><td>Coffe Break
10:20 - 10:50</td><td rowspan="2">Special Sessions
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10:50 - 11:30</td><td rowspan="3">Special Sessions
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11:30 - 13:30</td><td>D. Brydges
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<tr><td>Lunch Break
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<tr><td rowspan="3">Registration
Hotel Abadía
16:00 -20:00</td><td>Special Sessions
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18:20 - 19:10</td><td>G. Contreras
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Jardín San Francisco
Ex-hacienda San Gabriel de Barrera</td></tr>
<tr><td>Complimentary
Cocktail Party
20:30 - 22:30
Hotel Abadía</td><td>Callejoneada
(Social Activity)
20:30 - 22:00</td></tr>
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Plenary Speakers — Auditorium

Thursday	Friday	Saturday
F. González-Acuña 10:00 - 10:50	*M. Zworski* 09:30 - 10:20	*J. Urrutia* 09:30 - 10:20
		D. Brydges 12:45 - 13:35
P. Guan 18:20 - 19:10	*G. Contreras* 18:20 - 19:10	

DAVID BRYDGES, University of British Columbia, Canada
[Saturday September 23, 12:45]
Self-Avoiding Walks and Trees

A long chain molecule can be crudely modeled as a sequence of N points in $\mathbb{R}^d$ where the first point is at the origin. The sequence is admissible if each point is the centre of a sphere such that the spheres are non-overlapping but touching each other in accordance with the topology of a chain. By putting a uniform distribution on the subset of $\mathbb{R}^{Nd}$ consisting of admissible sequences we can address basic questions such as what is the expected end-to-end distance when N is large?

Analogous questions can be posed for molecules with other topologies such as trees. An even more basic model for a long chain molecule is a self-avoiding walk on the simple cubic lattice $\mathbb{Z}^d$. I will review and discuss recent results related to this class of problems.

GONZALO CONTRERAS, CIMAT, México
[Friday September 22, 18:20]
C^2-densely the 2-sphere has an elliptic closed geodesic

We prove that a Riemannian metric on the 2-sphere or the projective plane can be C^2-approximated by one whose geodesic flow has an elliptic closed geodesic. This result was conjectured by M. Herman and also partially recovers in the generic case a claim by H. Poincaré for convex surfaces.

Consequences of this theorem are that there is a dense set of metrics in the 2-sphere whose geodesic flow is not ergodic and that there are no structurally stable geodesic flows on the 2-sphere.

I find this a beautiful example of the use of modern dynamical systems in Riemannian geometry.

FRANCISCO GONZÁLEZ ACUÑA, Instituto de Matemáticas, UNAM & CIMAT
[Thursday September 21, 10:00]
Minimal coverings of a 3-manifold with special open subsets

What is the minimal number of "special" open subsets U of a closed 3-manifold M^3 that cover it?

We will discuss this question with the following nine meanings of the word "special":

absolute
1. Homeomorphic to $\mathbb{R}^3$
2. Homeomorphic to $S^1 \times \mathbb{R}^2$
3. Homeomorphic to an open subset of $\mathbb{R}^3$
4. Contractible (in themselves)

relative
5. Contractible in M^3
6. π_1-contractible in M^3
7. H_1-contractible in M^3
8. H-contractible in M^3
9. S^1-contractible in M^3.

PENGFEI GUAN, McGill University, Canada
[Thursday September 21, 18:20]
Nonlinear Differential Equations in Geometry

We will discuss some recent progress of nonlinear differential equations arising in geometry. Geometrically inspired problems provided the motivation for much of the development of the modern theory of nonlinear PDEs. In turn, the PDE theory plays a key role in solving some outstanding problems in geometry. We will concentrate on nonlinear scalar equations to illustrate some of the main ideas and techniques. These equations are related to the Christoffel–Minkowski problem, high codimension mean curvature flow and the problem of prescribing the σ_k curvature of a conformal metric.

JORGE URRUTIA, Instituto de Matemáticas, UNAM, Mexico
[Saturday September 23, 9:30]
Local Solutions For Global Problems in Wireless Networks

In this paper, we review a recently developed class of algorithms that solve *global* problems in unit distance wireless networks by means of *local algorithms*. A local algorithm is one in which any node of a network only has information on nodes at distance at most k from itself, for a constant k. For example, given a unit distance wireless network $\mathcal{N}$, we want to obtain a planar subnetwork of $\mathcal{N}$ by means of an algorithm in which all nodes can communicate only with their neighbors in $\mathcal{N}$, perform some operations, and then halt. We review algorithms for obtaining planar subnetworks, approximations to minimum weight spanning trees, Delaunay triangulations, and relative neighbor graphs. Given a unit distance wireless network $\mathcal{N}$, we present new local algorithms to solve the following problems:

1. Calculate small dominating sets (not necessarily connected) of $\mathcal{N}$.
2. Extract a bounded degree planar subgraph $\mathcal{H}$ of $\mathcal{N}$ and obtain a proper edge coloring of $\mathcal{H}$ with at most 12 colors.

The second of these algorithms can be used in the channel assignment problem.

MACIEJ ZWORSKI, University of California, Berkeley, USA
[Friday September 22, 9:30]
Quantum chaos in scattering theory

Models of quantum chaotic scattering include scattering by several convex bodies, open quantum maps, analysis on convex co-compact hyperbolic surfaces, and semiclassical potential scattering. In the talk, I will describe common features of these different models. The general goal will be to explain how classical objects, such as the thermodynamical pressure or dimension of the trapped set, affect quantum properties such as the decay rates or the density of states. I will concentrate on (colorful) pictures and intuitions rather than on the technical aspects of this (rather technical) subject.

Organizers: **R. Buchweitz** (Toronto), **J. A. de la Peña** (UNAM) and **A. Pianzola** (Alberta)

Thursday	Friday	Saturday
	V. Chernousov 10:50 - 11:20	*R. Buchweitz* 10:30 - 11:00
S. Iyengar 11:30 - 12:00	*F. Szetchman* 11:25 - 11:55	*J. A. de la Peña* 11:15 - 11:45
S. Liu 12:15 - 12:45	*A. Pianzola* 12:00 - 12:30	*R. Bautista* 12:00 - 12:30
G. Leuschke 13:00 - 13:30	*M. Barot* 12:40 - 13:10	
	Y. Billig 13:20 - 13:50	
X. Gómez-Mont 16:00 - 16:30	*I. Gutman* 16:00 - 16:30	
R. Martínez 16:45 - 17:15	*T. Bruestle* 16:45 - 17:15	
D. Vossieck 17:30 - 18:00	*J. Rada* 17:30 - 18:00	

MICHAEL BAROT, Instituto de Matemáticas, UNAM, Mexico
[Friday September 22, 12:40]
Graduated inclusions between simply-laced semi-simple Lie algebras: a description with unit forms

Denote by Δ and Γ two simply-laced *Dynkin types*, that is, disjoint unions of simply-laced Dynkin diagrams, and by $g(\Delta)$ and $g(\Gamma)$ the semi-simple Lie algebras of that type and recall that they are graduated by the root spaces $g(\Delta)_\alpha$.

When does there exist a *graduated* inclusion $\varphi\colon g(\Delta) \hookrightarrow g(\Gamma)$ (here graduated means: there exists a linear map f such that $\varphi\big(g(\Delta)_\alpha\big) \subseteq g(\Gamma)_{f(\alpha)}$)?

We translate this question into the language of *unit forms*, that is, integer quadratic forms $q\colon \mathbb{Z}^n \to \mathbb{Z}$ satisfying $g(c_i) = 1$ for each canonical base vector c_i. This enables us to give a complete answer to the previous question.

The talk will present results from a joint work with José Antonio de la Peña.

RAYMUNDO BAUTISTA, Instituto de Matemáticas, UNAM, México
[Saturday September 23, 12:00]
Representations of tame algebras over rational functions

In the following we use the following notation. If B is a finite-dimensional algebra over a field F, we denote by $B\text{-mod}$ the category of finitely generated left B-modules. By $F(x)$ we denote the field of rational functions over x. We put $F(x,y) = F(x)(y)$.

Let A be a finite-dimensional algebra over the algebraically closed field k. We put $A^{k(x)} = A \otimes_k k(x)$ and $A^{k(x,y)} = A \otimes_k k(x,y)$.

We prove the following result:

Theorem *The algebra A is of tame representation type if and only if for any indecomposable object M in $A^{k(x,y)}\text{-mod}$ such that ${}_{A^{k(y)}}M$ is an indecomposable $A^{k(y)}$-module, there is an indecomposable object N in $A^{k(x)}\text{-mod}$ with ${}_AN$ an indecomposable A-module such that*

$$M \cong N \otimes_{k(x)} k(x,y).$$

Joint work with Leonardo Salmerón.

YULY BILLIG, Carleton University, Ottawa, Canada
[Friday September 22, 13:20]
Thin coverings of modules

In this talk we will discuss a method of constructing graded-simple modules from ungraded simple modules over graded algebras (associative or Lie). This method works both in finite-dimensional and infinite-dimensional quasifinite set-ups. The key ingredient in our construction is the action of a cyclotomic quantum torus on the module. We apply this method to get a description of irreducible representations for the twisted toroidal Lie algebras.

This is based on a joint work with Michael Lau.

THOMAS BRUESTLE, Bishops and Université de Sherbrooke, Québec, Canada
[Friday September 22, 16:45]
Cyclic cluster algebras of rank three

Cluster algebras, introduced by Fomin and Zelevinsky a few years ago, have gained a lot of interest by now. Acylic cluster algebras have been shown to be related to cluster categories and tilted algebras. Cyclic cluster algebras, however, are less well understood.

We consider the first non-trivial case, cluster algebras of rank three (square, coefficient-free), and study which of them are cyclic. Rank three cluster algebras are given by triples of integers (x, y, z), and we provide an answer which involves the hyperplanes defined by

$$x^2 + y^2 + z^2 - xyz = c.$$

This is joint work with Ibrahim Assem, Martin Blais and Lutz Hille.

RAGNAR-OLAF BUCHWEITZ, University of Toronto at Scarborough, Canada
[Saturday September 23, 10:30]
Noncommutative Version of Hochschild Cohomology

It is a celebrated result by Gerstenhaber from 1964 that (classical) Hochschild cohomology is graded commutative for any associative algebra. Suarez–Alvarez's elegant treatment of the categorical Eckmann–Hilton argument yields easily the same property for derived Hochschild cohomology as defined by Quillen. There is a canonical algebra homomorphism from classical to derived Hochschild cohomology that factors through the Yoneda algebra of the self-extensions of the given algebra as a bimodule over itself.

The question addressed here is whether the latter Yoneda algebra might also always be graded commutative. That is known under mild "Tor-transversality" conditions, when that algebra already coincides with the derived version of Hochschild cohomology. Here we give a simple example, the normalization of a plane cusp singularity, where the answer is negative. Indeed, the Yoneda Ext-algebra in that case is essentially an infinitely generated tensor algebra.

VLADIMIR CHERNOUSOV, University of Alberta, Edmonton, Canada
[Friday September 22, 10:50]
Zero cycles on projective homogeneous varieties

We present a new method of computing the Chow group of zero cycles on projective homogeneous varieties which is based on an idea of parametrization of splitting fields.

JOSE ANTONIO DE LA PEÑA, Instituto de Matemáticas, UNAM, México
[Saturday September 23, 11:15]
Spectra of Coxeter polynomials

Let A be a finite dimensional algebra over an algebraically closed field k. Assume A has finite global dimension. The Auslander–Reiten translation τ_A defines an automorphism in the derived category of the module category mod_A. The linear transformation induced on the Grothendieck group is called the Coxeter transformation and the associated characteristic polynomial f_A is the Coxeter polynomial of A. The spectra of the Coxeter polynomial is related with important properties of the algebra: the structure of the Auslander–Reiten quiver of A, the growth of the iterated translations $\tau^n[X]$ for indecomposable modules X and other facts. For hereditary algebras $A = kQ$ with Q a quiver, f_A is known to be closely related to the characteristic polynomial of the adjacency matrix of the underlying graph of Q. We study new classes of algebras where the spectra of f_A can be described by means of characteristic polynomials of adjacency matrices of graphs.

XAVIER GÓMEZ MONT, CIMAT, México
[Thursday September 21, 16:00]
The Homological Index of a Vector Field on an Isolated Complete Intersection Singularity

Given a commutative square of finite free $\mathcal{O}$-modules, we construct a double complex of $\mathcal{O}$-modules, that we have called the Gobelin. (A Gobelin is a richly embroidered French wall tapestry.) The Gobelin is weaved with vertical and horizontal strands of the Buchsbaum–Eisenbud type, constructed each from a Koszul complex of half of the commutative square. We apply the Gobelin to compute the homological index of a germ of a holomorphic vector field on a complete intersection variety, having both an isolated singularity. The first spectral

sequence of the Gobelin provides free resolutions of the modules of Kähler differential forms on the complete intersection, and for small degree the homology of the Gobelin coincides with the homology of the complex obtained by contracting differential forms on the complete intersection with the vector field. The second spectral sequence of the Gobelin provides formulas to compute the homology groups of the Gobelin with local linear algebra.

IVAN GUTMAN, University of Kragujevac, Serbia
[Friday September 22, 16:00]
Energy of a Graph

Let G be a graph on n vertices. Let $\lambda_1, \lambda_2, \ldots, \lambda_n$ be its eigenvalues (*i.e.*, the eigenvalues of the adjacency matrix of G). The energy of G is defined as [1]

$$E(G) = \sum_{i=1}^{n} |\lambda_i|.$$

The name "energy" was chosen because in certain (limited) cases $E(G)$ is related to the energy of certain molecules. Some fundamental and some newest results on $E(G)$ [2] will be presented, and some open problems indicated.

The quantity

$$EE(G) = \sum_{i=1}^{n} e^{\lambda_i}$$

was recently proposed as a measure of "centrality" of complex networks [3]. Some properties of $EE(G)$ will also be discussed, in particular its relation to $E(G)$.

References

[1] I. Gutman, *The energy of a graph.* Ber. Math.-Statist. Sekt. Forsch. Graz **103**(1978), 1–22.

[2] *The energy of a graph: Old and new results.* Algebraic Combinatorics and Applications, Springer, Berlin, 2001, 196–211; *Spectra and energies of iterated line graphs of regular graphs.* Appl. Math. Lett. **18**(2005), 679–682; *Laplacian energy of a graph.* Lin. Algebra Appl. **414**(2006), 29–37; *Note on the Coulson integral formula.* J. Math. Chem. **39**(2006), 259–266.

[3] E. Estrada and J. A. Rodríguez-Velázquez, *Subgraph centrality in complex networks.* Phys. Rev. **E71**(2005), 056103.

SRIKANTH IYENGAR, University of Nebraska, Lincoln, USA
[Thursday September 21, 11:30]
Hochschild cohomological criteria for the Gorenstein property for commutative algebras

A classical result of Hochschild, Kostant, and Rosenberg characterizes smoothness of commutative algebras essentially of finite type over a field in terms of its Hochschild cohomology. I will discuss a similar characterization of the Gorenstein property.

This is joint work with L. L. Avramov.

GRAHAM LEUSCHKE, Syracuse University, USA
[Thursday September 21, 13:00]
Non-commutative desingularization of the generic determinant

In this joint work with Ragnar-Olaf Buchweitz and Michel Van den Bergh, we show that the hypersurface ring of the generic determinant admits a non-commutative crepant resolution by a "quiverized Clifford algebra".

SHIPING LIU, Université de Sherbrooke, Québec, Canada
[Thursday September 21, 12:15]
The derived category of algebras with radical squared zero

Let A be a finite dimensional elementary algebra over a field with $\mathrm{rad}(A)^0 = 0$. The objective is to study $D^b(A)$, the derived category of bounded complexes in the category of finite dimensional left A-modules. Our technique is to find a proper covering of the ordinary quiver of A so that the complexes of projective A-modules are determined by the representations of the covering. In this way, we are able to give a complete description of the indecomposables, the almost split triangles, the shapes of the components of the Auslander–Reiten quiver of $D^b(A)$ as well as the derived type of A.

This is a joint work with Raymundo Bautista.

ROBERTO MARTÍNEZ, Instituto de Matemáticas, UNAM, México
[Thursday September 21, 16:45]
On a group graded version of BGG

A major result in Algebraic Geometry is the theorem of Bernstein–Gelfand–Gelfand that states the existence of an equivalence of triangulated categories: $\underline{\mathrm{gr}}_\Lambda \cong \mathcal{D}^b(\mathrm{Coh}\, P^n)$, where $\underline{\mathrm{gr}}_\Lambda$ denotes the stable category of finitely generated graded modules over the $n+1$ exterior algebra and $\mathcal{D}^b(\mathrm{Coh}\, P^n)$ is the derived category of bounded complexes of coherent sheaves on projective space P^n.

Generalizations of this result were obtained in a paper by Martínez-Villa and Saorín and from a different point of view, the theorem has been extended by Yanagawa to Z^n-graded modules over the polynomial algebra. This generalization has important applications in combinatorial commutative algebra.

The aim of the talk is to show how to extend the results to group graded algebras in order to obtain a generalization of Yangawa's results having in mind the application to other settings.

ARTURO PIANZOLA, University of Alberta, Edmonton, Canada
[Friday September 22, 12:00]
Almost commuting subgroups of Lie groups and toroidal Lie algebras

Almost commuting subgroups of Lie groups appear naturally in many areas of Mathematics and Physics (*e.g.* flat connections on tori). The main purpose of this talk is to explain how these subgroups also arise in the Galois cohomology attached to toroidal Lie Algebras.

JUAN RADA, Unversidad de Los Andes, Venezuela
[Friday September 22, 17:30]
A generalization of the energy to digraphs

The adjacency matrix $A = (a_{ij})$ of a graph G with set of vertices $\{v_1, \ldots, v_n\}$ and set of edges E_G is defined as

$$a_{ij} = \begin{cases} 1 & \text{if } v_i v_j \in E_G \\ 0 & \text{if } v_i v_j \notin E_G. \end{cases}$$

The eigenvalues of the graph G are the eigenvalues of the adjacency matrix A. Since A is real and symmetric, the eigenvalues $\lambda_1, \ldots, \lambda_n$ of G are real numbers. The energy of G, denoted by $E(G)$, is defined as

$$E(G) = \sum_{i=1}^{n} |\lambda_i|.$$

One of the long-known results in this field is the Coulson integral formula. In this article, we extend the concept of energy to directed graphs in such a way that Coulson Integral Formula remains valid. As a consequence, it is shown that the energy is increasing over the set $\mathcal{D}_{n,h}$ of digraphs with n vertices and cycles of length h, with respect to a quasi-order relation. Applications to the problem of extremal values for the energy in various classes of digraphs are considered.

FERNANDO SZETCHMAN, University of Regina, Saskatchewan, Canada
[Friday September 22, 11:25]
Irreducible representations of Sylow subgroups of symplectic groups

We construct a canonical family of irreducible representations of a Sylow p-subgroup of the symplectic group $\mathrm{Sp}_{2n}(q)$, where q is a power of an odd prime p. Some of these representations appear in the Weil and Steinberg modules of $\mathrm{Sp}_{2n}(q)$, and a connection between the 2-modular reduction of these will be discussed.

DIETER VOSSIECK, Universidad Michoacana San Nicolás de Hidalgo, México
[Thursday September 21, 17:30]
Rigid homomorphisms between finite length modules over a discrete valuation ring

The category $\mathcal{L}_R$ of finite length modules over a discrete valuation ring R is easy to understand: its isomorphism classes correspond bijectively to partitions. However, the category of homomorphisms between finite length R-modules is "wild" and a complete classification of the orbits in $\mathrm{Hom}_R(X,Y)$ under the action of $\mathrm{Aut}_R(X) \times \mathrm{Aut}_R(Y)$ (for all $X, Y \in \mathcal{L}_R$) in terms of normal forms is a hopeless task.

Some time ago we could show that $\mathrm{Hom}_R(X,Y)$ always admits a unique orbit of "rigid" or "generic" homomorphisms. (In the case of the formal power series algebra $R = \mathbf{C}[[T]]$, this means precisely that with respect to the Zariski topology there is a dense open orbit; in the case of the ring of p-adic integers $R = \mathbf{Z}_p$ a similar geometric interpretation can be achieved, using the formalism of Witt vectors.) Moreover we classified the indecomposable rigid homomorphisms, which surprisingly turn out to be certain "strings".

In our talk we will present an algorithm which constructs for given $X, Y \in \mathcal{L}_R$ the essentially unique rigid homomorphism $X \to Y$.

Differential Geometry — Room 4

Organizers: **P. Guan** (McGill), **L. Hernández** (CIMAT) and **M. Wang** (McMaster)

Thursday	Friday	Saturday
N. Kamran 11:30 - 12:20	*J. Chen* 10:50 - 11:40	*A. Chau* 10:30 - 11:20
	P. Bayard 11:50 - 12:10	
R. Quiroga 12:30 - 13:30	*F. Sánchez* 12:20 - 13:10	*J. Petean* 11:30 - 12:30
	K. Chu 13:20 - 13:50	
C. Boyer 16:00 - 16:50	*J. Muciño* 16:00 - 16:50	
A. Sánchez 17:00 - 18:00	*R. Herrera* 17:00 - 18:00	

PIERRE BAYARD, Universidad Michoacana de San Nicolás de Hidalgo, Morelia, México
[Friday September 22, 11:50]
Entire spacelike hypersurfaces with prescribed curvature in Minkowski space

We present some new results concerning existence and uniqueness of entire spacelike hypersurfaces with prescribed scalar and prescribed Gauss curvature in Minkowski space. The constructions rely on analyzing a fully nonlinear elliptic partial differential equation on $\mathbb{R}^n$.

CHARLES BOYER, University of New Mexico, Albuquerque, USA
[Thursday September 21, 16:00]
On Toric Sasakian Geometry

A toric Sasakian structure is a toric contact structure with a compatible Sasakian metric whose isometry group contains the torus of the toric contact stucture. We lay the foundations for the study of toric Sasakian geometry by studying the Sasaki cone lying in the Lie algebra of the torus together with its underlying CR structure. In particular, we discuss the existence of both regular and irregular toric Sasakian structures in dimension 5 as well as its relation to the Sasaki–Einstein case.

ALBERT CHAU, University of Waterloo, Canada
[Saturday September 23, 10:30]
On the uniformization of complete non-negatively curved Kahler manifolds

First introducted in 1982 by Richard Hamilton, the Ricci flow is among the most important differential equations in geometry. It has provided the solution to many fundamental problems in topology, geometry and geometric analysis. In recent joint work with Prof. L. F. Tam, we study the Ricci flow on non-compact non-negatively curved Kahler manifolds and apply this to Yau's uniformization conjecture. In the talk I will discuss recent results arising from this study.

JINGYI CHEN, The University of British Columbia, Canada
[Friday September 22, 10:50]
Minimal surfaces with isotropic link

Let Σ be an immerse closed minimal surface in S^5 which is isotropic. We show that: if the genus of Σ is 0 then it is Legendrian and totally geodesic, and if the genus g is larger than 0 then either Σ is Legendrian or it has exactly $2g-2$ Legendrian points.

KENNETH CHU, University of Texas at Austin, USA
[Friday September 22, 13:20]
On the geometry of the moduli space of real binary octics

The moduli space of smooth real binary octics has five connected components, respectively parametrizing the real binary octics with $0, 1, \ldots, 4$ complex-conjugate pairs of roots. In this talk, we describe a hyperbolic structure on the GIT-stable completion of each component as an arithmetic quotient of real hyperbolic 5-space, following earlier work of Allcock–Carlson–Toledo on real cubic surfaces. We will also explain how to see that the Allcock–Carlson–Toledo construction of the moduli space of stable real binary octics fails to be a hyperbolic orbifold.

RAFAEL HERRERA, CIMAT, México
[Friday September 22, 17:00]
Parallel Quaternionic Spinors and Riamnnian holonomy

Spin manifolds are distinguished among oriented smooth manifolds by admitting a principal bundle double-covering their orthonormal-frame bundle, which gives rise to new vector bundles whose sections are called spinors. The condition can be relaxed to allow complex-spin structures (well-known due to Seiberg–Witten theory) and, more generally, quaternionic-spin structures. I will describe the geometric consequences of the existence of a parallel spinor on quaternionic-spin manifolds from the holonomy view-point, and how this generalizes the spin and complex-spin cases.

NIKY KAMRAN, McGill University, Canada
[Thursday September 21, 11:30]
Analytic Lie pseudogroups of infinite type

We will first review Elie Cartan's construction of the generalized Maurer–Cartan equations for Lie pseudogroups of infinite type. We will then show how to construct charts for isotropy subgroups in terms of convergent infinite products of exponentials of vector fields chosen in a suitable bounded filtered basis. The existence of such a basis follows from an estimate of Malgrange, which is central to his proof of the Cartan–Kaehler Theorem.

JESUS MUCIÑO, Instituto de Matemáticas, UNAM, México
[Friday September 22, 16:00]
Moduli spaces of singular flat metrics from meromorphic one forms

Meromorphic one forms on Riemann surfaces give origin to singular flat Riemannian metrics. We consider the associated moduli spaces. Applications to the Jacobian conjecture are given.

JIMMY PETEAN, CIMAT, México
[Saturday September 23, 11:30]
On the Yamabe invariant of products

The Yamabe invariant of a closed manifold appears naturally when studying the Hilbert–Einstein functional, the integral of the scalar curvature over the manifold. Computations of the invariant are difficult, in particular when it is positive (and there is no unicity of constant scalar curvature metrics on a conformal class). In this talk I will survey what is known about the computations and discuss some new results (joint work with K. Akutagawa and L. Floti) concerned with the Yamabe constants of Riemannian products.

RAUL QUIROGA, CIMAT–CINVESTAV, México
[Thursday September 21, 12:30]
Superrigidity, semisimple Lie groups and pseudoRiemannian geometry

Consider a smooth action of a simple noncompact Lie group G on a compact manifold M preserving some sort of geometric structure. The work led by Zimmer, among others, has shown that such actions are extremely rigid in the sense that there are strong restrictions on the manifold M. A conjecture of Zimmer states that, in the presence of a finite G-invariant ergodic measure, such manifold M is essentially of the form $M = K\backslash H/\Gamma$, where H is a Lie group containing G as a subgroup, Γ is a lattice in H and K is a compact subgroup of H that centralizes G. In this talk we will discuss some advances in proving such conjecture in the case where M is a pseudoRiemannian manifold and G acts preserving the pseudoRiemannian metric of M.

ADOLFO SÁNCHEZ, CIMAT, México
[Thursday September 21, 17:00]
Looking for a natural notion of superspace

It will be shown, in a self-contained and rather elementary fashion, how to classify all the Lie superalgebras that are associated naturally (*i.e.*, via the adjoint representation) to a given real or complex 3-dimensional Lie algebra. The same classification problem over the 4-dimensional real Lie algebra of the unitary group U_2 will also be approached, and its connection with Minkowski spacetime will be discussed.

FEDERICO SÁNCHEZ, Facultad de Ciencias, UNAM, México
[Friday September 22, 12:20]
Geometrical extrinsic dynamics of Riemannian submanifolds

An n-dimensional submanifold M of a Riemannian m-dimensional manifold Q, $n < m$ endowed with the second fundamental form has associated a set of foliations with singularities depending on its normal fields. These foliations, defined by quadratic differentials on M, are closely related to the extrinsic geometry of the submanifold. We analyze some properties of them in this context: The index of certain types of its isolated singularities and the possibility to reduce the codimension of the submanifold keeping an optimal class of these foliations.

Organizers: **Hugo Arizmendi** (UNAM), **Anthony Lau** (Alberta) and **Lourdes Palacios** (UAM)

Thursday	Friday	Saturday
S. Pérez-Esteva 11:30 - 12:20	*J. Borwein* 10:50 - 11:40	*V. Troitsky* 10:30 - 10:50
	R. Martínez-Avendaño 11:50 - 12:10	*F. Galaz* 11:00 - 11:20
N. Spronk 12:30 - 12:50	*L. Marcoux* 12:20 - 12:40	*L. Baribeau* 11:30 - 11:50
	S. Djorjevich 12:50 - 13:10	
Z. Hu 13:00 - 13:30	*M. Lamoureux* 13:20 - 13:40	
C. Bosch 16:00 - 16:20	*M. Sangani Monfared* 16:00 - 16:20	
A. García 16:30 - 16:50	*M. Neufang* 16:30 - 16:50	
A. Wawrzyncyk 17:00 - 17:20	*B. Gamboa de Buen* 17:00 - 17:20	
L. Palacios 17:30 - 18:00	*A. Livak* 17:30 - 18:00	

LINE BARIBEAU, Université Laval, Québec, Canada
[Saturday September 23, 11:30]
The spectral Schwarz lemma revisited

An algebroid function $K(z)$ is the set-valued function obtained by taking the zeroes of a polynomial whose coefficients are holomorphic functions of z. We present a sharpened version of the Schwarz lemma for algebroid functions, and discuss it in the context of the spectral Nevanlinna–Pick problem.

JONATHAN BORWEIN, Dalhousie University, Canada
[Friday September 22, 10:50]
Maximality of Sums of Monotone Operators

We say a multifunction $T\colon X \mapsto 2^{X^*}$ is *monotone* provided that for any $x, y \in X$, and $x^* \in T(x)$, $y^* \in T(y)$,

$$\langle y - x, y^* - x^* \rangle \geq 0,$$

and that T is *maximal monotone* if its graph is not properly included in any other monotone graph. The *convex subdifferential* in Banach space and a *skew linear matrix* are the canonical examples of maximal monotone multifunctions. Maximal monotone operators play an important role in functional analysis, optimization and partial differential equation theory, with applications in subjects such as mathematical economics and robust control. In this talk, based on [1], I shall show how—based largely on a long-neglected observation of Fitzpatrick —the originally quite complex theory of monotone operators can be almost entirely reduced to convex analysis. I shall also highlight various long standing open questions which these new techniques offer new access to.

References

[1] J. M. Borwein, *Maximal Monotonicity via Convex Analysis*. J. Convex Analysis (Special issue in memory of Simon Fitzpatrick) **13** (June 2006). [D-drive Preprint 281].

CARLOS BOSCH, Instituto Tecnólogico Autónomo de México, México
[Thursday September 21, 16:00]
Multipliers of Temperate Distributions

We will show that the space Oq of multipliers of temperate distributions can be expressed as the inductive limit of certain Hilbert spaces.
Joint work with Jan Kucera.

SLAVISA DJORJEVICH, Facultad de Ciencias Físico–Matemáticas, BUAP, México
[Friday September 22, 12:50]
Spectrum of Upper Triangular Operator Matrices

Let H and K be Banach spaces, let $B(H,K)$ denote the set of bounded linear operators from H to K, and abbreviate $B(H,H)$ to $B(H)$. For the operators $A \in B(H)$, $B \in B(K)$ and $C \in B(K,H)$, let M_C denote the operator matrices in $B(H \oplus K)$ defined with

$$M_C = \begin{pmatrix} A & C \\ 0 & B \end{pmatrix} : H \oplus K \to H \oplus K. \tag{1}$$

In this talk we will describe spectrum, Weyl's and Browder's spectrum of operator matrices M_C using spectral property of operators A and B.

FERNANDO GALAZ, CIMAT, UAM–Iztapalapa, México
[Saturday September 23, 11:00]
Iterating the Cesaro operator

Given a complex sequence $s = \{a_n\}$, the discrete Cesaro operator T assigns to it the sequence $Ts = \{b_n\}$, where $b_n = \frac{a_0+\cdots+a_n}{n+1}$, $n = 0, 1, \ldots$. If s is a convergent sequence, we prove that $\{T^n s\}$ converges if, and only if, $a_1 = \lim_{n\to\infty} a_n$. We also establish a corresponding result for the continuous Cesaro operator defined on $C[0,1]$.

BERTA GAMBOA DE BUEN, CIMAT, México
[Friday September 22, 17:00]
Empty intersection of slices and the fixed point property in Banach spaces

We prove that the condition of the empty slice property (EIS), which is a generalization of uniform smoothness, implies the fixed point property. That is, in a Banach space with EIS, every nonexpansive map from a weakly compact convex set into itself has a fixed point. Furthermore, the EIS property is stable under finite l^p sums of Banach spaces. We also give some examples.

(Joint work with Helga Fetter)

ARMANDO GARCÍA, Instituto de Matemáticas, UNAM, México
[Thursday September 21, 16:30]
An extension of Ekeland's variational principle to locally complete spaces

We prove an extension of Ekeland's variational principle to locally complete spaces which uses subadditive, strictly increasing continuous functions as perturbations.

ZHIGUO HU, University of Windsor, Ontario, Canada
[Thursday September 21, 13:00]
Multipliers and topological centre problems

We present some recent results on multipliers of a Banach algebra and their applications to topological centre problems.

The talk is based on joint work with Matthias Neufang and Zhong-Jin Ruan.

MICHAEL LAMOUREUX, University of Calgary, Canada
[Friday September 22, 13:20]
Linear operators and minimum phase

Geophysical applications demand a mathematical modeling of physical processes that respect minimum phase conditions. Essentially, this states that energy in a signal is concentrated near the beginning of the onset of a signal. We present a mathematical definition of minimum phase, develop robust calculation of equivalent minimum phase signals, and examine the class of linear operators on Hilbert space that preserve minimum phase. Properties are closely connected to factorization problems in Hardy space.

ALEXANDER LIVAK, University of Alberta, Edmonton, Canada
[Friday September 22, 17:30]
A covering lemma and its applications

An entropy lemma states that if we control the diameter of a body on a subspace then we control the covering of the body. More precisely, given two centrally-symmetric bodies K and L, satisfying $K \subset AL$ and $K \cap E \subset aL$ for a k-codimensional subspace E, one has $N(K, 2rL) \leq \big(4A/(r-a)\big)^k$ for every $r > a$. That means that, surprisingly, the covering numbers of K behave in the same way as the covering numbers of a cylinder with the base $aL \cap E$. We prove this lemma and discuss its applications to the Gelfand numbers and to the Sudakov inequality.

This talk is based on joint works with A. Pajor and N. Tomczak-Jaegermann and with V. Milman, A. Pajor, and N. Tomczak-Jaegermann.

LAURENT MARCOUX, University of Waterloo, Ontario, Canada
[Friday September 22, 12:20]
Sums of small numbers of commutators

For many C^*-algebras $\mathcal{A}$, techniques have been developed to show that all elements which have trace zero with respect to all tracial states can be written as a sum of finitely many commutators, and that the number of commutators required depends only upon the algebra, and not upon the individual elements. In this paper, we show that if the same holds for $q\mathcal{A}q$ whenever q is a "sufficiently small" projection in $\mathcal{A}$, then every element that is a sum of finitely many commutators in $\mathcal{A}$ is in fact a sum of two. We use these results to show that many C^*-algebras are linearly spanned by their projections.

RUBEN MARTÍNEZ AVENDAÑO, Universidad Autónoma del Estado de Hidalgo, México
[Friday September 22, 11:50]
Eigenmatrices and operators commuting with finite-rank operators

Using eigenmatrices, we characterize when a bounded operator in Hilbert space commutes with a finite-rank operator. We use this characterization to prove that if an operator commutes with a finite-rank operator, then it must commute with an operator of rank one. As a corollary of this, we show that (classical) Toeplitz operators do not commute with operators of finite rank.

MATTHIAS NEUFANG, Carleton University, Ottawa, Canada
[Friday September 22, 16:30]
Quantum groups and quantum information theory

Let $\mathbb{G} = (\mathcal{M}, \Gamma, \varphi, \psi)$ be a co-amenable locally compact quantum group. In recent work with M. Junge and Z.-J. Ruan, we have constructed and studied a completely isometric representation of the algebra of completely bounded (right) multipliers of $L_1(\mathbb{G})$ on $\mathcal{B}\big(L_2(\mathbb{G})\big)$. This extends and unifies earlier work by F. Ghahramani, E. Størmer and myself in the case $\mathcal{M} = L_\infty(G)$, and by Z.-J. Ruan, N. Spronk and myself for $\mathcal{M} = VN(G)$, where G is a locally compact group. We have shown that the multiplier algebra can in fact be identified with the algebra of completely bounded, normal $\widehat{\mathcal{M}}$-bimodule maps on $\mathcal{B}\big(L_2(\mathbb{G})\big)$ leaving $\mathcal{M}$ invariant. The part of the latter algebra consisting of completely positive maps provides a natural class of quantum channels which, from the viewpoint of quantum computing, are of particular interest in the case of finite-dimensional quantum groups.

In this talk, we shall discuss various applications of the above representation to quantum information theory. Indeed, several properties of our channels are highly desirable with regard

to quantum error correction: the bimodule property means precisely that the channels are noiseless for $\widehat{\mathcal{M}}$; moreover, every such channel has a symbol which is easy to retrieve, and the completely bounded minimal entropy (*cb-entropy*) can be calculated explicitly. Note that the cb-entropy has recently be shown to be additive (I. Devetak, M. Junge, C. King, and M. B. Ruskai); proving additivity of the bounded minimal entropy is a major open problem in quantum information theory.

This is joint work with Marius Junge, David Kribs and Zhong-Jin Ruan.

LOURDES PALACIOS, Universidad Autónoma Metropolitana–Iztapalapa, México
[Thursday September 21, 17:30]
On the boundary of the topologically invertible elements

It is well known that in a Banach Algebra, the boundary of the group of invertible elements is contained in the set of the topological divisors of zero. There are certain extensions of some of these concepts and results to more general algebras. We will talk about these generalizations and discuss some related examples.

SALVADOR PÉREZ ESTEVA, Instituto de Matemáticas, UNAM, México
[Thursday September 21, 11:30]
Atomic decompositions in Banach-valued Hardy spaces on Lipschitz domains

We prove an atomic decomposition for all the Borel measures that arise as boundary limits of Banach-valued harmonic functions on a Lipschitz domain D, whose non-tangential maximal function is integrable with respect to harmonic measure of the boundary of D. As in the case of the disk, the existence of non-tangential boundary limits of all these harmonic functions characterizes the Radon–Nikodym property of the Banach space.

MEHDI SANGANI MONFARED, University of Windsor, Canada
[Friday September 22, 16:00]
Character Amenability of Banach Algebras

The notion of character amenability of Banach algebras will be discussed. It will be shown that for a locally compact group G, the amenability of either of the group algebra $L^1(G)$ or the Fourier algebra $A(G)$ is equivalent to the amenability of the underlying group G.

We also discuss some cohomological implications of character amenability. In particular we show that if A is a commutative character amenable Banach algebra, then $\mathcal{H}^n(A, E) = \{0\}$ for all finite-dimensional Banach A-bimodules E, and all $n \in \mathbb{N}$. This in particular implies that all finite-dimensional extensions of such Banach algebras split strongly. This extends

earlier results of H. Steiniger and myself on Fourier and generalized Fourier algebras to the larger class of commutative character amenable Banach algebras.

NICO SPRONK, University of Waterloo, Ontario, Canada
[Thursday September 21, 12:30]
The algebra generated by idempotents in a Fourier-Stieltjes algebra

Let G be a locally compact group. The Fourier–Stieltjes algebra $B(G)$ is the dual space of the group C^*-algebra $C^*(G)$, and it can be naturally be made into Banach algebra which can be identified with a subalgebra of the bounded continuous functions on G. If G is abelian, then $B(G)$ is exactly the algebra of Fourier–Stieltjes transforms of measures on the dual group. As such, $B(G)$ is a large commutative Banach algebra and, frequently, has an intractable spectrum and is not regular.

We consider the closed span of the idempotents in $B(G)$, $B_I(G)$. Even for totally disconnected groups, $B_I(G)$ is a regular Banach algebra. M. Ilie and I have computed the spectrum of $B_I(G)$, and characterised, for another locally compact group H, when $B_I(G)$ is isometrically algebraically isomorphic to $B_I(H)$. We have also computed some examples. This represents an application of the "spine" of $B(G)$, which we defined previously, and has a nice application in amenability theory.

VLADIMIR TROITSKY, University of Alberta, Canada
[Saturday September 23, 10:30]
Minimal vectors and invariant subspaces

The method of minimal vectors was developed to find invariant subspaces of certain classes of operators on Hilbert spaces. We describe applications of this method to Banach spaces, Banach lattices, and algebras of operators.

ANTONI WAWRZYNCYK, Universidad Autónoma Metropolitana–Iztapalapa, México
[Thursday September 21, 17:00]
Schur Lemma and the spectral mapping formula

Let B be a complex topological unital algebra. The left joint spectrum of a set $S \subset B$ consisting of pairwise commuting elements is defined by the formula

$$\sigma_l(S) = \Big\{(\lambda(s))_{s\in S} \in \mathbb{C}^S \;\Big|\; \sum_{s\in S} B(s-\lambda(s)) \text{ is a proper ideal}\Big\}.$$

Using the Schur Lemma and the Gelfand–Mazur theorem we prove that $\sigma_l(S)$ has the spectral mapping property for the following algebras:

(i) B—a locally convex (F)-algebra with all maximal left ideals closed,

(ii) B—an m-convex algebra with all maximal left ideals closed,

(iii) B—a locally convex Waelbroeck algebra.

The right ideals version of the result is also valid.

Organizers: **I. Gitler** (CINVESTAV), **L. Goddyn** (SFU) and **B. Reed** (McGill)

Thursday	Friday	Saturday
	R. Villarreal 10:50 - 11:20	*L. Goddyn* 10:30 - 11:00
B. Reed 11:30 - 12:00	*V. Jungic* 11:25 - 11:55	*G. Salazar* 11:10 - 11:40
E. Rivera-Campo 12:05 - 12:35	*H. Galeana* 12:00 - 12:30	*M. Devos* 11:50 - 12:20
L. B. Richmond 12:40 - 13:10	*J. Verstraete* 12:40 - 13:10	
L. Montejano 13:15 - 13:45	*I. Gitler* 13:15 - 13:45	
P. Lisonek 16:15 - 16:45	*K. Webb* 16:15 - 16:45	
M. A. Pizaña 16:55 - 17:25	*C. Valencia* 16:55 - 17:25	
F. Zaragoza 17:30 - 18:00	*P. Haxell* 17:30 - 18:00	

MATT DEVOS, Simon Fraser University, Canada
[Saturday September 23, 11:50]
A generalization of Kneser's addition theorem

Two important topics in the study of additive abelian groups are sumsets and subsequence sums. In joint work with B. Mohar and L. Goddyn, we have studied a unification of these two problems.

Let $A_1, A_2, \ldots, A_n$ be a sequence of finite subsets of an (additive abelian) group. Define a group element g to be a k-sum if g can be expressed as a sum of group elements from k distinct terms of this sequence. Our main problem of interest will be finding a (natural) lower bound on the number of (distinct) k-sums.

The study of sumsets is the special case when $n = k = 2$ and here M. Kneser proved an important lower bound. The study of subsequence sums is the special case when every set A_i has size one. Here there have been a number of interesting lower bounds, due to Hamidoune, Bollobas–Leader, Grynkiewicz, and others. We prove a general lower bound on the number of distinct k-sums which generalizes all of these results.

HORTENSIA GALEANA, Instituto de Matemáticas, UNAM, México
[Friday September 22, 12:00]
Hypergraph transversals and kernels in digraphs

In this work we relate the existence of certain transversals of square hypergraphs with the existence of kernels in digraphs. This method allows us to propose and to prove several results on the existence of kernels in digraphs. In particular we have the following: In 1980, H. Meyniel conjectured that if D is a digraph such that every odd directed cycle has at least two pseudodiagonals, then D has a kernel. Although this conjecture was disproved by Galeana–Sánchez (1982), the following modificationn of Meyniel's Conjecture still holds: If D is a digraph such that every Ω-odd cycle has at least two Ω-pseudodiagonals, then D has a kernel. Some open problems are proposed.

ISIDORO GITLER, CINVESTAV, México
[Friday September 22, 13:15]
On a new class of Mengerian hypergraphs

We study the normality of the Rees algebra associated to a clutter and the relations with the conjecture of Conforti and Cornuéjols about the packing properties on clutters. This conjecture states that all the clutters with the packing property have the MFMC property. We show that this conjecture is equivalent to an algebraic statement about the normality of the Rees algebra. Finally we introduce a new infinite class of hypergraphs that verify the conjecture of Conforti and Cornuéjols.

Definition 1 The clutter $\mathcal{C}$ satisfies the *max-flow min-cut* (MFMC) property (or is called Mengerian) if both sides of the LP-duality equation

$$\min\{\langle \alpha, x\rangle \mid x \geq 0 \; ; \; xA \geq \mathbf{1}\} = \max\{\langle y, \mathbf{1}\rangle \mid y \geq 0 \; ; \; Ay \leq \alpha\} \tag{1}$$

have integral optimum solutions x and y for each non-negative integral vector α.

We denote the smallest number of vertices in any minimal vertex cover of $\mathcal{C}$ by $\alpha_0(\mathcal{C})$ and the maximum number of independent edges of $\mathcal{C}$ by $\beta_1(\mathcal{C})$.

Definition 2 If $\alpha_0(\mathcal{C}) = \beta_1(\mathcal{C})$ we say that the clutter $\mathcal{C}$ has the König property.

Definition 3 A clutter $\mathcal{C}$ satisfies the $packing\ property$ (PP) if all its minors satisfy the König property.

Proposition 1 *If $\mathcal{C}$ has the max-flow min-cut property, then $\mathcal{C}$ has the packing property.*

Conjecture 1 (Conforti-Cornuéjols) If the clutter $\mathcal{C}$ has the packing property, then $\mathcal{C}$ has the max-flow min-cut property.

This conjecture continues to be open. The only cases known are for binary matroids (Seymour), and dyadic hypergrphs (Cornuejols, Guenin and Margot).

In this talk we give a new infinite family Q^F_{pq} of hypergrahs that verify the conjecture of Conforti and Cornuéjols. This new class is neither binary nor dyadic.

LUIS GODDYN, Simon Fraser University, Canada
[Saturday September 23, 10:30]
Circular colouring of even-faced embedded graphs

We consider nonbipartite graphs embedded on a surface where all faces have even length. One might guess that such graphs are "nearly bipartite", if all the odd cycles are long. This guess is false since there exist 4-chromatic quadrangulations of the projective plane with arbitrary odd girth. For topological reasons, all even-faced nonbipartite projective planar graphs have their circular chromatic numbers bounded away from 2. For other surfaces, such as the torus or Klein bottle, the topological obstruction might not exist and the situation becomes much more interesting.

PENNY HAXELL, University of Waterloo, Ontario, Canada
[Friday September 22, 17:30]
Hypergraph intersections

We give some sufficient conditions for a pair of hypergraphs to intersect. We also discuss some applications.

VESELIN JUNGIC, Simon Fraser University, British Columbia, Canada
[Friday September 22, 11:25]
Rainbow Ramsey Theory

The rainbow Ramsey theory could be defined as a collection of results which, given a finite coloring of some structure, guarantee the existence of certain rainbow configurations or substructores.

Radoičić conjectured in 2001 that every equinumerous 3-coloring of $\{1, 2 \ldots, 3n\}$ contains a 3-term rainbow arithmetic progression, *i.e.*, an arithmetic progression whose terms are colored with distinct colors. This conjecture initiated a series of results having rainbow structures as the common theme.

In this presentation an overview of the current state in the rainbow Ramsey theory will be given. I will list and describe some of the recent published and unpublished results obtained by Axenovich, Conlon, Fox, Jungić, Mahdian, Martin, Radoičić, and Serra.

A few conjectures and open problems will be mentioned.

PETR LISONEK, Simon Fraser University, BC, Canada
[Thursday September 21, 16:15]
Rainbow Graphs in Steganography

A k-regular graph is called a "rainbow graph" if it admits a proper vertex colouring with $k+1$ colours such that, for each vertex v, all neighbors of v receive distinct colors. We survey some constructions of rainbow graphs; in particular we note that the d-dimensional integer lattice graph Z^d is rainbow for each d. We discuss an application of this result in steganography.

LUIS MONTEJANO, Instituto de Matemáticas, UNAM, México
[Thursday September 21, 13:15]
Colorable Transversal Theory

We shall discuss several colorable line and k-plane transversal theorems under the spirit of Barani and Lovasz.

MIGUEL ANGEL PIZAÑA, Universidad Autónoma Metropolitana–Iztapalapa, México
[Thursday September 21, 16:55]
Graph Relations and Clique Divergence

Given a graph G, its *clique graph* $K(G)$ is the intersection graph of all its (maximal) cliques. *Iterated clique graphs* are defined by $K^0(G) = G$ and $K^{n+1}(G) = K\big(K^n(G)\big)$. A graph G is said to be clique divergent if the sequence of orders $|G|, |K(G)|, |K^2(G)|, \ldots, |K^n(G)|, \ldots$ diverges. A graph relation $f\colon G \to H$ is a relation of sets $f \subseteq V(G) \times V(H)$ such that $f(X)$ induces a complete subgraph of H whenever X induces a complete subgraph of G. Here, we introduce a technique for proving clique divergence of graphs using graph relations. As a consequence we prove that every surface admits a (Whitney) triangulation whose underlying graph is clique divergent.

BRUCE REED, McGill University, Montreal; CNRS, Sophia–Antipolis, Canada
[Thursday September 21, 11:30]
Erdős–Posa Property for Cycles of Prescribed Length

Neumann-Lara proved that the Erdős–Posa property holds for even cycles, *i.e.*, he showed that for all k there is an $f(k)$ such that every graph either has k vertex disjoint odd cycles or contains a set X of at most $f(k)$ vertices intersecting every odd cycle. Here we discuss the Erdős–Posa property for various families of cycles, including odd cycles, cycles length zero mod m for arbitrary m, long cycles, and cycles which are non-zero mod m for odd m.

L. BRUCE RICHMOND, University of Waterloo, Ontario, Canada
[Thursday September 21, 12:40]
Baby-Steps Giant-Steps in Polynomial Factorization

The average cost of baby-step/giant-step polynomial factoring algorithms is considered. The distribution of the degrees of the irreducible factors of a random polynomial of degree n is relevant. Consider a partition of $[1, 2, \ldots, n]$ into intervals. Intervals that contain more than one irreducible factor degree are called *multi-factor intervals*. The fastest algorithms so far separate the product of all the irreducible factors of the polynomial with degrees belonging to a given interval from the other factors. If the interval is not multi-factor there is no need of further computation for this interval. If the interval is multifactor the product of the irreducible polynomials with degrees in the interval is computed. One expects to have more factors of lower degrees than higher degrees. One considers therefore partitions with growing interval sizes. The best partitions are what we look for. This was done for polynomials over F_2 by von zur Gauthen and Gerhard. The approach we follow uses generating functions and the asymptotics of their coefficients.

EDUARDO RIVERA CAMPO, Universidad Autónoma Metropolitana–Iztapalapa, México
[Thursday September 21, 12:05]
Partitions of complete geometric graphs into plane trees

We give a sufficient condition for a complete geometric graph with $2n$ vertices to have a partition into n plane spanning trees. For the case where the vertices are in convex position, we characterise all such partitions.

This is joint work with P. Bose, F. Hurtado and D. R. Wood.

GELASIO SALAZAR, Universidad Autónoma de San Luis Potosí, México
[Saturday September 23, 11:10]
On pseudolinear crossing numbers

We will talk about the pseudolinear crossing number of a graph, a parameter which lies between the usual and the rectilinear crossing number. The pseudolinear crossing number is a natural generalization of the rectilinear crossing number, and has the advantage that its computation is a purely combinatorial problem. We will present some recent results regarding the pseudolinear crossing number of the complete graphs.

CARLOS VALENCIA, CINVESTAV; Instituto de Matemáticas, UNAM, México
[Friday September 22, 16:55]
Connected graphs with a minimal number of edges

In this talk we will give a lower bound for the number of edges of a connected graph as a function of the stability number α and the covering number τ. More precisely we will show that

$$q(G) \geq \alpha(G) - c(G) + \Gamma\big(\alpha(G), \tau(G)\big),$$

where $c(G)$ is the number of connected components of G and

$$\Gamma(a,t) = \min\left\{ \sum_{i=1}^{a} \binom{z_i}{2} \;\middle|\; z_1 + \cdots + z_a = a + t \text{ and } z_i \geq 0 \,\forall\, i = 1, \ldots, a \right\},$$

for a and t two arbitrary natural numbers.

This result is a variant for connected graphs from a Turán's theorem for the minimal number of edges of a graph with fixed stability number and order. We will also discuss the generalization of this result for k-connected graphs with $k \geq 2$.

JACQUES VERSTRAETE, University of Waterloo and McGill University, Canada
[Friday September 22, 12:40]
Cycles in sparse graphs

The central theme of this talk is to study the largest possible average degree $d(n, S)$ of an n-vertex graph with no cycle of length from a given set of positive integers S.

When S contains only odd numbers, the extremal graphs are complete bipartite graphs, so $d(2n, S) = n$ in this case. When S contains even numbers, the problem becomes notoriously difficult. The case $S = \{2k\}$ is Erdős' Even Cycle Theorem. In this talk I will give a short proof of this theorem, which states $d(n, S)$ is at most about $n^{1/k}$. The method used to prove this allows us to consider any set S of forbidden even cycle lengths: a general theorem will be presented which shows that apart from chaotic looking sets S, $d(n, S)$ is at most about $\exp(\log^* n)$. This is motivated by a conjecture of Erdős that $d(n, S)$ is a constant when S is the set of powers of two. Very surprisingly, our result is tight: there exist sets S for which $d(n, S)$ is roughly $\exp(\log^* n)$.

RAFAEL VILLARREAL, CINVESTAV, México
[Friday September 22, 10:50]
Ring graphs and complete intersection toric ideals

We study the family of simple graphs whose number of primitive cycles equals its cycle rank. It is shown that this family is "constructible" and that it is precisely the family of ring graphs. Then we study the complete intersection property of toric ideals of simple and oriented graphs.

KERRI WEBB, University of Lethbridge, Alberta, Canada
[Friday September 22, 16:15]
Balanced Graphs

A bipartite graph in which every induced circuit has length divisible by four is said to be *balanced*. Balanced graphs were introduced by Berge, and have an important role in linear programming. We discuss structural results for vertex transitive balanced graphs.

FRANCISCO ZARAGOZA MARTÍNEZ, Universidad Autónoma Metropolitana–Azcapotzalco, México
[Thursday September 21, 17:30]
Irreducible triangulations of surfaces

Let S be a closed surface with Euler genus $\gamma(S)$. An irreducible triangulation of S is a simple graph G without contractible edges embedded on S so that each face is a triangle and any two faces share at most two vertices. Nakamoto and Ota proved that the number n of vertices of an irreducible triangulation of S is bounded above by $171\gamma(S) - 72$. This bound was improved by Cheng, Dey, and Poon to $n \leq 120\gamma(S)$ for orientable surfaces. We improve these bounds to $n \leq 106.5\gamma(S) - 33$ for any closed surface S.

This is joint work with Gloria Aguilar Cruz at the Department of Mathematics of CINVESTAV.

Organizers: **T. Minzoni** (IIMAS-UNAM) and **M. Ward** (UBC)

Thursday	Friday	Saturday
	T. Hillen 10:50 - 11:40	*M. Ward* 10:30 - 11:20
L. Cisneros 11:30 - 12:20	*T. Kolokolnikov* 11:50 - 12:40	*R. Wittenberg* 11:30 - 12:30
J. Fujioka 12:30 - 13:30	*A. Oberman* 12:50 - 13:50	
M. C. Jorge 16:00 - 16:50	*P. Panayotaros*[a] 16:00 - 16:50 [a]Part II, see page 78	
R. Kuske 17:00 - 18:00	*A. Vargas* 17:00 - 18:00	

LUIS CISNEROS, Universidad Nacional Autónoma de México, México
[Thursday September 21, 11:30]
A numerical study on the two-dimensional discrete sine-Gordon equation

It is known that the continuous two-dimensional sine-Gordon equation does not support radial symmetric solutions. Radial initial conditions collapse in finite time. We study numerically the discrete version of this problem, and we obtain radial symmetric solutions that do not collapse. We show using the modulation theory that the collapse is prevented by the Peierls–Nabarro potential generated by the discreteness of the problem. It is also shown that there is a threshold of radial velocities above which the Peierls–Nabarro potential is not enough to stop the collapse. The modulation theory is shown to compare favorably with the numerical solution.

JORGE FUJIOKA, Instituto de Física, UNAM, México
[Thursday September 21, 12:30]
Systems with Embedded Solitons

At the end of the nineties a brand-new type of solitons were discovered: *the embedded solitons*. Initially they were found in optical systems, and afterwards they were also found in hydrodynamical models, liquid crystal theory and discrete systems. These peculiar solitary waves are interesting because they exist under conditions in which, until recently, it was considered that the propagation of solitons was impossible. In the beginning it was considered that these nonlinear waves were necessarily isolated and unstable, but later on it was found that they can be stable and may exist in families. In the present communication it is explained what these *embedded solitons* are, in which models they have been found, and what variants exist (stable, unstable, continuous, discrete, *etc.*).

THOMAS HILLEN, University of Alberta, Edmonton, Canada
[Friday September 22, 10:50]
A Classification of Spikes and Plateaus

In this talk I will give a formal classification of spikes versus plateaus. One of the most interesting properties of PDE's is the potential to generate spatial patterns, which are of relevance in physical or biological applications. Some patterns are made from thin and pointed local maxima, others contain wide maxima with a flat plateau. I will use the fourth order derivative to distinguish between these types and call them "spikes" and "plateaus". This classification supports the common use of spikes or plateaus (for example for Gray–Scott, or Cahn–Hilliard models). Moreover, the classification forms a helpful tool to analyse stability of spatial patterns of PDE's, including reaction-diffusion systems and chemotaxis systems.

MARI CARMEN JORGE, IIMAS, UNAM, México
[Thursday September 21, 16:00]
A note on interface and bubble type asymptotic solutions to the two-dimensional Cahn–Hilliard equation

In this work we construct asymptotic solutions to the two-dimensional steady-state Cahn–Hilliard equation. Using variational methods we construct explicit approximate solutions of interface type. We also study the determination of the bubble type solutions inside a container with rigid walls. In this case the center of the bubble is completely determined.

THEODORE KOLOKOLNIKOV, Dalhousie University, Canada
[Friday September 22, 11:50]
Spot patterns in the BZ reaction

We study spot patterns in the BZ reaction. We show that these patterns can undergo two different types of self-replication. The first type of self-replication is due to fold point corresponding to a dissapearence of the steady state. The second type is due to an instability of the steady state. In the former case, the spot splits into a ring. In the latter case, the spot replicates into two spots, or forms finger-like patterns.

RACHEL KUSKE, University of British Columbia, Canada
[Thursday September 21, 17:00]
Noise-sensitivity in bursting: new approaches for quantitative analysis

The phenomenon of bursting, composed of alternating periods of active spiking and near quiescence, is observed in a variety of biological applications including neural and cellular dynamics. It has a complex sensitivity to noise which exhibits dynamical features from both the underlying deterministic behavior and the stochastic elements. We use a combined approach of approximating both the time dependent probability density and the stochastic multi-scale dynamics in order to understand contributions from both the deterministic and stochastic features. This approach leads to simplified approximate models which can be analyzed or simulated efficiently, providing quantitative measures of the noise sensitivity. To illustrate the new approaches, we focus on a model of bursting in dendritic spines. Generalizations to other applications with similar dynamics will also be discussed.

ADAM OBERMAN, Simon Fraser University, Burnaby, Canada
[Friday September 22, 12:50]
The Pucci Operator and Applications

This talk will focus on a little-known fully nonlinear elliptic second order Partial Differential Equation described by the Pucci Maximal and Minimal Operator.

We will present the ideas behind the equation.

We will illustrate some exciting applications and connections:

- the stochastic optimal control interpretation;
- formal homogenization results;
- the relation to the convex envelope operator; and
- application to image processing.

PANAYOTIS PANAYOTAROS, IIMAS, UNAM, México
[Friday September 22, 16:00]
Localized invariant tori in the discrete NLS with diffraction management

Part II, see page 83.

ARTURO VARGAS, IIMAS, UNAM, México
[Friday September 22, 17:00]
Evolution of Benjamin–Ono Solitons in the Presence of Weak Z-K Lateral Dispersion

The talk is about the effect of weak lateral dispersion of Z-K type on a Benjamin–Ono solitary wave. The asymptotic solution is based on an approximate variational solution for the solitary wave, which is then modulated in time through the use of conservation equations. The effect of the dispersive radiation shed as the solitary wave evolves is also included in the modulation equations. It is found that the weak lateral dispersion produces a strongly anisotropic, stable solitary wave which decays algebraically in the direction of propagation, as for the Benjamin–Ono solitary wave, and exponentially in the transverse direction. Also, it is found that the initial conditions with amplitude above a threshold evolve into solitary waves, while those with amplitude below the threshold evolve as lumps for a short time, then merge into radiation.

MICHAEL WARD, Univeristy of British Columbia, Vancouver, Canada
[Saturday September 23, 10:30]
Eigenvalue Optimization, Spikes, and the Neumann Green's Function

An optimization problem for the fundamental eigenvalue λ_0 of the Laplacian in a planar simply-connected domain that contains N small identically-shaped holes, each of a small radius $\epsilon \ll 1$, is considered. A Neumann boundary condition is imposed on the outer boundary of the domain and a Dirichlet condition is imposed on the boundary of each of the holes. For small hole radii ϵ, we derive an asymptotic expansion for λ_0 in terms of certain properties of the Neumann Green's function for the Laplacian. This expansion depends on the locations x_i, for $i = 1, \ldots, N$, of the small holes. For the unit disk, ring-type configurations of holes are constructed to optimize the eigenvalue with respect to the hole locations. This eigenvalue optimization problem is shown to be closely related to the problem of determining equilibrium vortex configurations in the Ginzburg–Landau theory of superconductivity, and is also relevant for constructing localized spike-type solutions to certain singularly perturbed reaction-diffusion systems. For these spike solutions, some stability results are also given.

RALF WITTENBERG, Simon Fraser University, Burnaby, Canada
[Saturday September 23, 11:30]
Attractors in one-dimensional spatiotemporal chaos

We discuss the dynamics on the attractor of a family of one-dimensional PDEs displaying spatiotemporally chaotic solutions, including the Kuramoto–Sivashinsky (KS) equation. We obtain bounds and estimates on the L^2 norm and attractor dimension. A sixth-order analogue of the KS equation, the Nikolaevskii model for short-wave pattern formation with Galilean invariance, displays a novel multiple-scale attractor. We show that existing modulation equation descriptions coupling the amplitudes for the patterned mode and mean flow, while asymptotically consistent, are incomplete. The attractor features spatiotemporal chaos with strong scale separation, coexistence of scaling regimes, anomalous exponents and Burgers-like viscous shocks. These are captured by higher-order corrections to the amplitude equations.

Organizers: **Víctor Núñez** (CIMAT) and **D. Rolfsen** (UBC)

Thursday	Friday	Saturday
	M. Culler 10:50 - 11:10	*S. Boyer* 10:30 - 10:50
D. Rolfsen 11:30 - 11:50	*H. Boden* 11:20 - 11:40	*E. Ramírez-Losada* 11:00 - 11:20
L. Armas 12:00 - 12:20	*G. Walsh* 11:50 - 12:10	*C. Laing* 11:30 - 11:50
G. Indurskis 12:30 - 12:50	*J. C. Gómez-Larrañaga* 12:20 - 12:40	*M. Neumann* 12:00 - 12:30
E. Jasso 13:00 - 13:30	*W. Heil* 12:50 - 13:10	
	H. Cabrera 13:20 - 13:50	
M. Scharlemann 16:00 - 16:20	*M. Eudave* 16:00 - 16:20	
M. Jordán-Santana 16:30 - 16:50	*D. Sumners* 16:30 - 17:00	
M. Vázquez 17:00 - 17:20		
V. Núñez 17:30 - 18:00		

NOTE: On Saturday, the Low Dimensional Topology session moves to Level H Room!

LORENA ARMAS, Instituto de Matemáticas, UNAM, México
[Thursday September 21, 12:00]
Paths in Open Book Decompositions

In this talk we give an algorithm to decide when a path with endpoints in the boundary of a disk with holes is simple, *i.e.*, it can be drawn without selfintersections. This algorithm is simpler than previous ones given by Zieschang, and by Matsumoto and Kamada.

This is a joint work with Francisco Gonzalez Acuña.

HANS BODEN, McMaster University, Canada
[Friday September 22, 11:20]
The $\mathrm{SL}(2,C)$ *Casson invariant*

We present some joint results with Cindy Curtis on the $\mathrm{SL}(2,C)$ Casson invariant for 3-manifolds. This invariant was defined by Curtis, who also established a surgery formula. Despite these results, only few computations of the invariant are known. One class of examples we explore are Seifert-fibered 3-manifolds, where we present a closed formula for the $\mathrm{SL}(2,C)$ Casson invariant which is interesting to compare with the corresponding formula for the $\mathrm{SU}(2)$ Casson. Moreover, combining these results with known results on the Culler–Shalen seminorms, we provide computations for families of 3-manifolds arising as Dehn surgeries on knots with Seifert slopes. This approach is used to investigate the behavior of the $\mathrm{SL}(2,C)$ Casson invariant for surgeries on twist knots and pretzel knots.

STEVEN BOYER, Université du Québec à Montréal, Canada
[Saturday September 23, 10:30]
On families of virtually fibred Montesinos link exteriors

William Thurston conjectured over twenty years ago that every finite volume hyperbolic 3-manifold is finitely covered by a manifold which fibres over the circle. The first non-trivial examples supporting the conjecture were obtained by Gabai and Reid. In a 1999 paper, Aitchison and Rubinstein found combinatorial conditions on certain polyhedral decompositions of 3-manifolds which guarantee the existence of such cover which fibres over the circle. In 2002, Chris Leinenger showed that every manifold obtained by Dehn filling one component of the Whitehead link exterior is finitely covered by a surface bundle and more recently Genevieve Walsh did the same for 2-bridge knot exteriors and certain Montesinos links. In this talk we show use construct several infinite families of Montesinos links which virtually fibre.

HUGO CABRERA IBARRA, IPICYT, México
[Friday September 22, 13:20]
Conway polynomials associated to 3-tangle closures

Given a certain type of oriented 3-string tangle, we consider five different ways for closing it to obtain knots or links and give formulas for calculating the Conway polynomials of the closures of the composition of two such 3-tangles.

MARC CULLER, University of Illinois at Chicago, USA
[Friday September 22, 10:50]
Homology of small-volume hyperbolic 3-manifolds

If a closed, orientable hyperbolic 3-manifold M has volume less than 1.219 then $H_1(M\,;Z)$ has rank at most 3. Moreover, unless M is an exceptional manifold in the sense of Gabai, Meyerhoff and N. Thurston, the rank of $H_1(M\,;Z_p)$ is at most 2 for any odd prime p. There are three examples of manifolds known with volume less than 1.219, one of which, namely the Weeks manifold, has mod 5 first homology of rank 2. The proof combines several deep results about hyperbolic 3-manifolds, including the work of Gabai–Meyerhoff–Thurston on maximal tube radius; the Marden Tameness Conjecture, proved by Agol and Calegari–Gabai; the $\log(2k-1)$ Theorem, proved with Anderson, Canary and Shalen; and bounds on volume change under Dehn filling obtained by Agol, Dunfield, Storm and W. Thurston using results from Perelman's work on Ricci flow. The basic strategy is to compare the volume of a tube about a shortest closed geodesic C in M with the volumes of tubes about closed geodesics in a sequence of hyperbolic manifolds obtained from M by Dehn surgeries on C.

This is joint work with Ian Agol and Peter Shalen.

MARIO EUDAVE, Instituto de Matemáticas, UNAM, México
[Friday September 22, 16:00]
Some examples of knots with interesting properties

In this talk we give some explicit examples of knots or links which give a positive answer to questions made by several people. First, for each odd number n, we find knots whose exterior contains a connected, orientable, incompressible surface with n boundary components, answering a question of F. Gonzalez-Acuña and A. Ramirez. Second, we construct knots whose exterior contains an incompressible torus with four boundary components, and a non-meridional slope; these examples are simpler that the ones given by the author some years ago, which answered a question made by J. Luecke. Third, for each rational number p/q, we find a link with two components $k_1 \cup k_2$, so that by doing p/q-Dehn surgery on k_1 gives a reducible manifold, answering a question of N. Sayari.

J. CARLOS GÓMEZ LARRAÑAGA, CIMAT, México
[Friday September 22, 12:20]
Lusternik–Schnirelmann type invariants for 3-Manifolds

We will talk about what is known about these invariants for 3-Manifolds.

WOLFGANG HEIL, Florida State University, USA
[Friday September 22, 12:50]
3-manifolds covered by three open balls or solid tori

Hempel and McMillan showed that a closed 3-manifold M that can be covered by three open balls is a connected sum of S^3 and S^2-bundles over S^1. We sketch a new proof of a slightly generalized result and show how the proof can be adapted to classify closed 3-manifolds covered by one open solid torus and two open balls or by two open solid tori and one open ball. We think that with these methods we will be able to handle the case for 3 open solid tori.

GABRIEL INDURSKIS, University of British Columbia, Vancouver, Canada
[Thursday September 21, 12:30]
Exceptional fillings of once-punctured torus bundles

Let M be a hyperbolic 3-manifold which is a bundle over the circle with a once-punctured torus as fibre. Its monodromy is conjugate in $\mathrm{SL}(2,\mathbb{Z})$ to the canonical form $\pm R^{a_1}L^{b_1}\cdots R^{a_n}L^{b_n}$ with positive exponents, where $n > 0$ and R and L are the upper and lower triangular matrices generating $\mathrm{SL}(2,\mathbb{Z})$. We show that when $n > 5$, there is only one non-hyperbolic Dehn filling of the bundle (namely the Dehn filling with slope isotopic to the boundary of the fibre). This concretizes a result of Bleiler and Hodgson which showed the existence of such a lower bound. The bound is sharp, as there are bundles with $n = 5$ which admit two exceptional fillings.

This is joint work with David Futer (Michigan State University).

EDGAR JASSO, Instituto de Matemáticas, UNAM, México
[Thursday September 21, 13:00]
On knots with Seifert Fibered Dehn Surgeries

For a hyperbolic knot in S^3 there are only finitely many Dehn surgeries yielding non-hyperbolic manifolds. In this talk we will present an infinite family of (hyperbolic) knots admitting a Seifert-fibered Dehn surgery; these knots do not arise from the primitive/Seifert-fibered

construction introduced by J. Dean a few years ago. The pretzel knot $(3, -3, 3)$ belongs to this family.

This is joint work with Mario Eudave-Muñoz.

MERCEDES JORDÁN-SANTANA, ICTP
[Thursday September 21, 16:30]
A geometric proof that the singular braid group is torsion-free

Singular Braids can be seen as the classical braids where we allow two strings to intersect. If the intersecting points are marked with white or black colour we can give the definition of life-disc in order to create a group, the singular braid group. In this talk we give the presentation of this group, its geometric description and some properties that help us to prove that this group is torsion-free.

CHRISTIAN LAING, Florida State University, USA
[Saturday September 23, 11:30]
Geometric Measures as Brain Shape Descriptors

Classification and identification of differences in brain anatomy (*i.e.*, differences in shape) can play an important role in Neuroscience. Methods such as Magnetic Resonance Imaging (MRI) are used to correlate brain structure and function, and to measure changes during development and disease.

Given a set of polygonal curves (not necessarily closed or connected), geometric measures involving combinations of writhe and average crossing numbers of subcurves, as well as ropelength and thickness, can be computed to obtain a set of features for the purpose of shape characterization. These measures, originally given for simple closed curves, can be defined in a natural way for a set of polygonal curves.

We apply these geometric measures to a set of curves obtained by tracing sulcal paths on the gray matter surface of human brains. These surfaces are extracted from MRI scans of human brains. We then compute these geometric measures to construct a feature vector which is used in a machine learning process. A clustering technique called multiple discriminant analysis is used to find an optimal projection of the feature space into a plane. This optimal planar projection minimizes the variance within a cluster, and maximizes the distance between distinct clusters.

In our preliminary results, an automatic differentiation between sulcal paths from the left or right hemispheres was possible. Also a male-female classification and younger-older classification was achievable.

MAX NEUMANN, Instituto de Matemáticas, UNAM, México
[Saturday September 23, 12:00]
Surfaces in semi-alternating knot complements

I want to consider knots made by glueing two alternating tangles (with few strings or with some other conditions) and look for essential surfaces in their complements.

VÍCTOR NÚÑEZ, CIMAT, México
[Thursday September 21, 17:30]
Coverings of Montesinos knots of the second kind

A Montesinos knot $k \subset S^3$ is a link that has a Seifert manifold as double branched covering, $B_2(k)$, and such that k is not a union of fibers of a Seifert fibering of the 3-sphere (this is not an exact definition, but the exceptions are few and non-interesting for us).

For the first kind of Montesinos knots, the double branched covering is an orientable Seifert manifold with orbit surface the 2-sphere. A Montesinos knot k is of the second kind, if $B_2(k)$ is an orientable Seifert manifold with orbit surface a non-orientable surface.

For a Montesinos knot k of the first kind, it is known how to get the 3-sphere as a dihedral branched covering of (S^3, k). We explain how to obtain the 3-sphere as a dihedral covering, and also as a 'meta-dihedral' branched covering of (S^3, k). These last 'meta-dihedral' coverings show a surprising and very interesting similarity with the study of Montesinos knots of the first kind.

Joint work with Jair Remigio.

ENRIQUE RAMÍREZ, CIMAT, México
[Saturday September 23, 11:00]
There exist infinitely many two component links which are 2-universal

A link or knot l is 2-universal if every closed orientable 3-manifold is a covering of S^3 branched along l, and each branching index is either one or two. In this work we give a family of 2-universal links.

DALE ROLFSEN, University of British Columbia, Vancouver, Canada
[Thursday September 21, 11:30]
On R-covered foliations of 3-manifolds

A codimension one foliation of a manifold is said to be R-covered if the space of leaves of the pullback of the foliation to the universal cover is homeomorphic to the real line. Sometimes

the definition also requires that the foliation of the manifold be transversely oriented, but we will not assume this.

We will present a family of 3-manifolds which possess R-covered foliations, but on the other hand cannot be given a foliation which is both transversely oriented and R-covered. We use a theorem of Calegari and Dunfield that if a 3-manifold has a transversely oriented R-covered foliation, then its fundamental group is left-orderable. Our examples are Haken manifolds which have finite homology groups, possess R-covered foliations, but have non-left-orderable fundamental groups.

MARTY SCHARLEMANN, University of California, Santa Barbara, USA
[Thursday September 21, 16:00]
Straightening tube sums

Suppose the complement of a 3-manifold $W \subset S^3$ contains an incompressible torus T. Then there is a natural way to reimbed W in a typically simpler form, namely reimbed the solid torus that T bounds in S^3 as an unknotted solid torus. When T is of higher genus there is not such a natural choice of reimbedding. For the special genus two case in which T is a tubed sum of two distant tori there is a natural choice. We show how this case suffices as a 3-dimensional tool to prove the genus three, 4-dimensional Schoenflies Conjecture.

DEWITT SUMNERS, Florida State University, USA
[Friday September 22, 16:30]
DNA Knots Reveal Chiral Packing of DNA in Phage Capsids

Bacteriophages are viruses that infect bacteria. They pack their double-stranded DNA genomes to near-crystalline density in viral capsids and achieve one of the highest levels of DNA condensation found in nature. Despite numerous studies some essential properties of the packaging geometry of the DNA inside the phage capsid are still unknown. Although viral DNA is linear double-stranded with sticky ends, the linear viral DNA quickly becomes cyclic when removed from the capsid, and for some viral DNA the observed knot probability is an astounding 95%. This talk will discuss comparison of the observed viral knot spectrum with the simulated knot spectrum, concluding that the packing geometry of the DNA inside the capsid is non-random and writhe-directed.

References

[1] J. Arsuaga, M. Vázquez, S. Trigueros, D. W. Sumners and J. Roca, *Knotting probability of DNA molecules confined in restricted volumes: DNA knotting in phage capsids*. Proc. Natl. Acad. Sci. USA **99**(2002), 5373–5377.

[2] J. Arsuaga, M. Vázquez, P. McGuirk, D. W. Sumners and J. Roca, *DNA Knots Reveal Chiral Organization of DNA in Phage Capsids.* Proc. Natl. Acad. Sci. USA **102**(2005), 9165–9169.

[3] C. Micheletti, D. Marenduzzo, E. Orlandini and D. W. Sumners, *Knotting of Random Ring Polymers in Confined Spaces.* J. Chem. Phys. **124**(2006), 064903 (1–10).

MARIEL VÁZQUEZ, San Francisco State University, USA
[Thursday September 21, 17:00]
Processes of topology simplification in biology

Important Biological processes such as replication, transcription and recombination involve global topological changes of long DNA molecules. Circular DNA adopts different topological conformations in the cell, negative supercoiling being its preferred, native state. There is evidence that knots inhibit replication and transcription, and it is known that links with two or more components prevent proper segregation at cell division. The cell has thus devised ways to reduce topological entanglement. I will talk about recent models of DNA unknotting and unlinking both from a biological, a mathematical and a computational point of view.

This is joint work with J. Arsuaga, I. Grainge, X. Hua, D. Sherratt and S. Trigueros.

GENEVIEVE WALSH, University of Quebec at Montreal and Tufts University, Canada
[Friday September 22, 11:50]
Commensurability classes of two-bridge knot complements

Two 3-manifolds are said to be commensurable if they have a common finite-sheeted cover. Commensurability classes are a reasonable way to organize hyperbolic 3-manifolds. For example, if a manifold is virtually fibered or virtually Haken, then so is every manifold in its commensurability class. However, the general problem of determining if two hyperbolic 3-manifolds are commensurable is difficult. We show that a hyperbolic 2-bridge knot complement is the unique knot complement (in S^3) in its commensurability class. The proof relies heavily on facts particular to 2-bridge knots.

There are commensurability classes that contain more than one hyperbolic knot complement. For example, this can happen if one of the knots admits a lens space surgery. We speculate on the general case.
This is joint work with Alan Reid.

Organizers: **D. Brydges** (UBC), **S. Sontz** (CIMAT) and **C. Villegas** (UNAM-Cuernavaca)

Thursday	Friday	Saturday
R. Weder 11:30 - 12:20	*R. Moody* 10:50 - 11:40	
	R. del Río 11:50 - 12:10	
J. Quastel 12:30 - 12:50	*R. Froese* 12:20 - 12:40	*Discussion Session* 10:30 - 12:30
P. Zhevandrov 13:00 - 13:30	*L. Silva* 12:50 - 13:10	
	J. Toloza 13:20 - 13:50	
G. Slade 16:00 - 16:20	*D. Jakobsen* 16:00 - 16:20	
A. Jarai 16:30 - 16:50	*C. Villegas* 16:30 - 16:50	
J. Cruz 17:00 - 17:20	*A. Turbiner* 17:00 - 17:20	
A. Hernández 17:30 - 18:00	*S. Sontz* 17:30 - 18:00	

JAIME CRUZ SAMPEDRO, Universidad Autónoma del Estado de Hidalgo, México
[Thursday September 21, 17:00]
Embedded Eigenvalues of Continuous and Discrete Schrödinger Operators

First we present general results about the instability of embedded eigenvalues in the continuum, and then we treat in more detail the instability of embedded eigenvalues of one dimensional Schroedinger operators, with Wigner–von Neumann-like potentials, both in the continuous and the discrete cases.

RAFAEL DEL RÍO, UNAM, México
[Friday September 22, 11:50]
Sturm–Liouville operators in the half axis with local perturbations

We give conditions which imply equivalence of the Lebesgue measure with respect to a measure μ generated as an average of spectral measures corresponding to Sturm–Liouville operators in the half axis. We apply this to prove that some spectral properties of these operators hold for large sets of boundary conditions if and only if they hold for large sets of positive local perturbations.

This is joint work with O. Tchebotareva.

RICHARD FROESE, University of British Columbia, Canada
[Friday September 22, 12:20]
AC spectrum for Schrödinger operators on tree-like graphs

I will discuss recent proofs, obtained with Hasler and Spitzer, of the existence of absolutely continuous spectrum for Schrödinger operators on graphs.

ANTONIO HERNÁNDEZ, IIMAS, UNAM, México
[Thursday September 21, 17:30]
Symmetry breaking and adiabatic invariants

We will discuss adiabatic momentum maps in the context of examples of mechanical systems with approximate symmetry. A procedure for averaging the "variational principle" will be described.

DIMITRI JAKOBSEN, McGill University, Montreal, Canada
[Friday September 22, 16:00]
Estimates from below for spectral function and error term in Weyl law

We obtain asymptotic lower bounds for the spectral function of the Laplacian on compact manifolds. In the negatively curved case, thermodynamic formalism is applied to improve the estimates. Our results can be considered pointwise versions (on a general manifold) of Hardy's lower bounds for the error term in the Gauss circle problem. We next obtain a lower bound for the remainder in Weyl's law on negatively curved surfaces. On higher-dimensional negatively curved manifolds, we prove a similar bound for the oscillatory error term. Our approach uses wave trace asymptotics, equidistribution of closed geodesics and small-scale microlocalization.

ANTAL JARAI, Carleton University, Ottawa, Canada
[Thursday September 21, 16:30]
Random walk on a critical oriented percolation cluster in high dimensions

We study simple random walk on a critical oriented percolation cluster in $d+1$ dimensions, where $d > 6$, and show that it is subdiffusive. Our results confirm that the walk behaves qualitatively the same way as on a critical Galton–Watson tree conditioned to survive; a case studied by Kesten in 1986. Our percolation model has a finite range L that we need to take sufficiently large. We condition the cluster of the origin to survive for a long time n, and we let n go to infinity. Given the cluster, a random walk is started at the origin, and observed until it exits the ball of radius R (in the graph-distance). We show that the expected (annealed) exit time from the ball is of order R^3. Our method is based on estimates of volume growth and effective resistance.

Joint work with M. Barlow, T. Kumagai and G. Slade.

ROBERT MOODY, University of Victoria, Canada
[Friday September 22, 10:50]
Between order and disorder: the mathematics of quasicrystals

Quasicrystals are materials that lie somewhere between crystals and disordered materials. This talk is an introduction to the mathematics that has been created to model and explain them. We will start with various characterizations of mathematical crystals, where the underlying structure is based on lattices, and show how nicely these can be generalized to encompass some of this intermediate world of aperiodic order.

A characteristic feature of quasicrystals is their crystal-like diffraction, which is deeply related to their internal order. We will indicate some of the known ways of producing aperiodic pure point diffractive sets and the current state of trying to characterize them.

At the end of the day, aperiodic order seems to be a reconciliation of precise local order and average global order. We will show how, through the use of dynamical systems, this idea can be made more precise.

JEREMY QUASTEL, University of Toronto, Canada
[Thursday September 21, 12:30]
Effect of Noise on Traveling Fronts in the Fisher–KPP equation

KPP-type reaction-diffusion equations perturbed by noise have random traveling fronts. We compute the speed asymptotically for small values of the noise. As conjectured by Brunet and Derrida, the slowdown is as the inverse square of the logarithm of the noise, with an explicit constant.

LUIS SILVA, IIMAS, UNAM, México
[Friday September 22, 12:50]
Applications of M. G. Krein's Theory of Entire Operators to Sampling Theory

The Whittaker–Shannon–Kotel'nikov Sampling Theorem gives a formula for reconstructing Paley–Wiener functions from their values at a discrete set of points (samples). This theorem has been extended and generalized in various ways.

In this talk we consider a generalization of the Whittaker–Shannon–Kotel'nikov Sampling Theorem on the basis of a particular class of simple symmetric operators with deficiency indices $(1, 1)$. The theory of this class of operators is due to M. G. Krein.

This is a joint work with Julio H. Toloza.

GORDON SLADE, University of British Columbia, Vancouver, Canada
[Thursday September 21, 16:00]
Invasion percolation on a tree

Invasion percolation is a stochastic growth process which produces a random infinite subgraph—the invaded region—of a given infinite graph G. We consider the case where G is a regular tree and study the large-scale properties of the invaded region. Viewed far from the origin, the invaded region looks locally like a large critical percolation cluster. But surprisingly, we prove that the global structure of the invaded region is dramatically different than that of the incipient infinite percolation cluster.

This is joint work with O. Angel, J. Goodman and F. den Hollander.

STEPHEN SONTZ, CIMAT, México
[Friday September 22, 17:30]
Heat kernel analysis in a deformation of quantum mechanics

We present a μ-deformation of quantum mechanics based on Dunkl operators, as studied by Rosenblum. This includes a μ-deformed Segal–Bargmann space and an asssociated μ-deformed Segal–Bargmann transform. We show the relation of these structures to heat kernel analysis, following ideas introduced by Hall.

JULIO TOLOZA, UNAM, México
[Friday September 22, 13:20]
Absence of continuous spectrum on a class of unbounded Jacobi operators

We establish sufficient conditions for self-adjointness on a class of unbounded Jacobi operators defined by matrices with main diagonal sequence of very slow growth and rapidly growing off-diagonal entries. With some additional assumptions, we also prove that these operators have only discrete spectrum.

ALEXANDER TURBINER, Instituto de Ciencias Nucleares, UNAM, México
[Friday September 22, 17:00]
Anharmonic oscillator and double-well potential: approximating eigenfunctions

A simple uniform approximation of the logarithmic derivative of the ground state eigenfunction for both the quantum-mechanical anharmonic oscillator and the double-well potential given by $V = m^2x^2+gx^4$ at arbitrary $g \geq 0$ for $m^2 > 0$ and $m^2 < 0$, respectively, is presented. It is shown that if this approximation is taken as unperturbed problem it leads to an extremely fast convergent perturbation theory. A connection with WKB approximation is briefly discussed.

Dedicated to the memory of Professor Felix A. Berezin.

CARLOS VILLEGAS, Instituto de Matemáticas, UNAM, México
[Friday September 22, 16:30]
Asymtotics of clusters of eigenvalues for perturbations of the hydrogen atom Hamiltonian

We present in this talk a limiting eigenvalue distribution theorem for the Schrödinger operator of the hydrogen atom (with the Planck parameter $\hbar$ included) plus ϵ times a bounded continuous function Q. By considering suitable dilation operators, we prove that taking $\epsilon = O(\hbar^2)$ we obtain well defined clusters of eigenvalues around the energy $E = -1/2$ whose limiting distribution involves the Radon transform of the function Q along the classical orbits of the Kepler problem with energy $E = -1/2$ with respect to an integration over the space of

geodesics of the 3-sphere S^3. The idea of the proof involves a well known unitary transformation from the Hilbert space generated by the bound states of the hydrogen atom onto $L^2(S^3)$ and coherent states on the sphere S^3. We will comment on the generalization of the theorem above to the n-dimensional case and when Q is a pseudodifferential operator of order zero.

RICARDO WEDER, UNAM, México
[Thursday September 21, 11:30]
Inverse Scattering at a Fixed Energy

We prove that the averaged scattering solutions to the Schrödinger equation with short-range electromagnetic potentials (V, A) where $V(x) = O(|x|^{-\rho})$, $A(x) = O(|x|^{-\rho})$, $|x| \to \infty$, $\rho > 1$, are dense in the set of all solutions to the Schrödinger equation that are in $L^2(K)$ where K is any connected bounded open set in $\mathbb{R}^n$, $n \geq 2$, with smooth boundary.

We use this result to prove that if two short-range electromagnetic potentials (V_1, A_1) and (V_2, A_2) in $\mathbb{R}^n$, $n \geq 3$, have the same scattering matrix at a fixed positive energy and if the electric potentials V_j and the magnetic fields $F_j := \operatorname{curl} A_j$, $j = 1, 2$, coincide outside of some ball they necessarily coincide everywhere.

In a previous paper of Weder and Yafaev the case of electric potentials and magnetic fields in $\mathbb{R}^n$, $n \geq 3$, that are asymptotic sums of homogeneous terms at infinity was studied. It was proven that all these terms can be uniquely reconstructed from the singularities in the forward direction of the scattering amplitude at a fixed positive energy.

The combination of the new uniqueness result of this paper and the result of Weder and Yafaev implies that the scattering matrix at a fixed positive energy uniquely determines electric potentials and magnetic fields that are a finite sum of homogeneous terms at infinity, or more generally, that are asymptotic sums of homogeneous terms that actually converge, respectively, to the electric potential and to the magnetic field.

PETR ZHEVANDROV, University of Cartagena, Colombia
[Thursday September 21, 13:00]
Water waves guided by underwater obstacles

It is well-known that underwater obstacles such as ridges and submerged horizontal cylinders can serve as waveguides for surface water waves. It is also known that for large values of the wavenumber k in the direction of the ridge or cylinder, there is only one guided wave. We construct the corresponding eigenfunctions and eigenfrequencies assuming that $k \to \infty$ by means of reducing the initial problem to a pair of boundary integral equations and then solving them by applying the method of Zhevandrov and Merzon (Amer. Math. Soc. Transl. (2) **208**(2003), p. 235). The resulting formulas are infinite convergent series of the Neumann type, which reduce to quite simple asymptotics of the eigenfrequencies as $k \to \infty$.

Organizers: C. Kieran (UQAM) and M. Santillán (UPN)

Thursday	Friday	Saturday
The training of teachers of mathematics: A mathematician's perspective *B. Hodgson, A. Díaz-Barriga* 11:30 - 13:30	The use of technology in the teaching and learning of mathematics: A research perspective *C. Kieran, T. Cedillo, F. Hitt* 10:50 - 13:50	The learning of mathematics from various research perspectives *L. Radford, O. Figueras* 10:30 -12:30
The training of teachers of mathematics: A mathematics educator's perspective *F. Glanfield, M. Santillán* 16:00 - 18:00	The use of technology in the teaching and learning of mathematics: A practitioner or curricular perspective *T. Steinke, A. Ramírez* 16:00 - 18:00	

TENOCH CEDILLO, Universidad Pedagógica Nacional, México

The potential of CAS in promoting changes in teachers' mathematical knowledge, practices and conceptions

This presentation will discuss a study aimed at providing plausible answers to the following questions:

- In which ways do middle school mathematics teachers take advantage of the algebraic transformation facilities offered by a CAS?
- In which ways does the use of CAS influence teachers' mathematical knowledge?
- In which ways do mathematics teachers change their practices as a result of using CAS in their teaching?

From the beginning of the study the teachers seemed to be convinced of the potential of CAS facilities to stimulate their students to explore, put forward and test mathematical conjectures. At this point it seemed interesting for the aims of this study to investigate why they also seemed to be reluctant to use those CAS facilities to carry out algebraic transformations. During the interviews it was found that teachers' reluctance was due to the value they gave to students' learning of algebraic transformation rules by paper-and-pencil techniques. However, they acknowledged that most of their students learn the algebraic algorithms meaninglessly.

I will discuss how teachers changed their view during the study and found how to take advantage of CAS in order to help their students learn in a more meaningful way such notions as how to simplify similar terms within an algebraic expression, the laws of exponents, and some non-conventional strategies to factor polynomial expressions "without making their students become key pushers".

ALEJANDRO DÍAZ-BARRIGA, Instituto de Matemáticas, México

A mathematician's perspective on teacher training in Mexico

Teacher training is done in Mexico at schools that are exclusively devoted to this aim, the "Escuelas Normales" and "Normales Superiores", depending on the level: the former for primary school (ages 6–12), the latter for secondary school (ages 12–15). Mathematics teachers of the baccalaureate level (ages 15–18) do not usually receive a pedagogical training but have degrees in subjects related to mathematics. Generally speaking, primary school pre-service teachers do at most one course in mathematics, and those who will become

mathematics teachers in secondary school do two or three. There is an agreement among mathematicians that teacher training (especially future maths teachers') lacks mathematics.

In this paper we will expand on this subject, stressing the importance of the manner in which mathematics should be taught. We will give some examples of this, particularly for the secondary and baccalaureate levels.

The session will be shared with Silvia Alatorre (Universidad Pedagógica Nacional).

OLIMPIA FIGUERAS, CINVESTAV, México

TBA

Not available

FLORENCE GLANFIELD, University of Saskatchewan, Saskatoon, Canada

A Reflection about Mathematics Teacher Education Programs in Canada

In this session I will first start by providing an overview of mathematics teacher preservice programs in Canada. These programs differ for those who will be elementary mathematics teachers and for those who will be secondary mathematics teachers. In almost all teacher education programs in Canada, preservice teachers are required to take at least one mathematics content course as well as a mathematics 'methods' course (a course that teaches you how to teach mathematics). Mathematics educators in Canada ask the following questions about the preservice programs: Are these requirements sufficient to become a mathematics teacher? Should preservice teachers take more mathematics courses? What mathematics should preservice teachers know? In my talk I will propose the question, "Are these the questions that mathematics educators should be asking?" In my experience and research many elementary (and some secondary) preservice teachers do not see 'themselves' in mathematics; they come to preservice education courses with certain understandings and perspectives about mathematics and what it means to teach mathematics. These understandings and perspectives are framed by the experiences that preservice teachers have had prior to entering and while enrolled in their teacher education programs. Perhaps the questions that mathematics educators should be asking are not related to the content. . . but related to what we do in our programs to 'shift' the understandings and perspectives of preservice teachers.

FERNANDO HITT, Université du Québec à Montréal, Canada

Reflexión sobre diferentes acercamientos en la enseñanza de las matemáticas en ambientes tecnológicos

Los profesores de matemáticas frente al uso de la tecnología en los procesos de enseñanza tienen, en general, posiciones extremas; una que va en contra del uso de la tecnología porque el profesor considera que su uso inhibe el aprendizaje y, la otra, con un entusiasmo desbordado, que la tecnología juega un papel fundamental en el aprendizaje de las matemáticas. Nos podemos preguntar cuál es la influencia que tienen los investigadores en la promoción implícita o explícita de estas posiciones. Quisiera, en esta exposición, analizar algunas investigaciones realizadas en ambientes tecnológicos en donde podríamos encontrar indicadores que nos permitan tener una posición crítica y reflexiva sobre el uso de tecnología, tanto en el terreno de la investigación sobre el estudio de fenómenos ligados al aprendizaje de las matemáticas como en su uso en los procesos de enseñanza.

BERNARD R. HODGSON, Département de mathématiques et de statistique, Université Laval, Québec G1K 7P4, Canada

The mathematical education of primary and secondary school teachers: the experience of Université Laval

In most Canadian universities, the education of pre-university teachers represents an important component of the task of the mathematics department, at least in terms of the number of students involved. Such is the case at Université Laval, where the Department of Mathematics and Statistics is responsible for several courses offered in the context of the pre-service education of teachers. These include two compulsory math courses given to prospective primary school teachers, and seven courses specific to prospective secondary school teachers.

The aim of this talk is to describe briefly the general framework of the mathematical education of school teachers at Université Laval and to discuss the main themes around which the content of the mathematics courses is articulated. Examples will be given of the mathematical topics presented in these courses; some of the pedagogical approaches will also be discussed.

Comments about both the departmental support of these activities, and the collaboration with colleagues from the Faculty of Education and from other departments of the Faculty of Sciences and Engineering, will be presented. A brief comparison will be made with other Canadian universities.

CAROLYN KIERAN, Université du Québec à Montréal, Canada

Using Computer Algebra Systems (CAS) in Teaching High School Mathematics: Two Research-Based Examples from Classroom Practice

The integration of new technologies in mathematics education has been an ongoing issue for the last two decades. Teachers and teacher educators are struggling with questions regarding the use of technological tools and their relation to required paper-and-pencil skills. The original optimism regarding the benefits of technology, which would allow a focus on conceptual understanding at the expense of calculation techniques, has become quite nuanced. This presentation will address the dialectical relation between theoretical thinking and technique, as they co-emerge in a combined computer algebra and paper-and-pencil environment. More particularly, it will focus on two Grade 10 teaching experiments involving CAS technology: the first one on equivalence, equality, and equation; the second one on generalizing and proving within factoring. Attention will be given to the nature of the tasks in which the students engaged and to students' ways of thinking within these tasks. Even though the topics are quite different, findings indicate the importance of the co-emergence of theory and technique in both cases.

LUIS RADFORD, Université Laurentienne, Sudbury, Ontario, Canada,

The Investigation of Motion and its Symbolic Mathematical Expression

Generally speaking perceptual activity, gestures, concrete actions, and natural language provide one with the basic resources to achieve a certain understanding of motion. However, as the studies conducted in the late Middle Ages suggest, the mathematical investigation of motion rests on a process of idealization achieved through the use of signs. This is why a mathematical investigation of motion requires not only the overcoming of the concrete experience and its intuitive, phenomenological key concepts (*e.g.* space, time, velocity), but also the understanding of new subtle concomitant forms of mathematical symbolization. In this presentation we pay attention to this idealization considered as a dialectic process between concepts and signs. We analyze some classroom excerpts that point to some of the students' difficulties in their attempt to understand and make sense of motion and its symbolic mathematical expression. It is suggested that rather than merely "representing" motion, algebraic symbolism (in its graphical or formulaic form) is an artifact. Algebraic symbolism mediates new ontogenetic ways of reflecting about the world that emphasize certain qualitative and quantitative relationships and leads to specific cultural conceptions of space, time and motion.

ARTURO RAMÍREZ, CIMAT, México

TBA

Not available

MARCELA SANTILLÁN, Universidad Pedagógica Nacional, México

TBA

Not available

THOMAS STEINKE, Ottawa–Carleton Catholic School Board, Ottawa, Canada

From Toys to Tools: Reflections of a Math Consultant on Implementing Technology in K–12 Math in Ottawa and Ontario

Tom will share his reflections on his school board and Ontario, province-wide experiences related to the implementation of technology in K–12 mathematics in policy, teacher professional learning, and resource development. The experiences relate predominantly to the challenges and opportunities related to the insertion of CAS (TI 89), dynamic statistics software (Fathom and TinkerPlots), dynamic geometry software (GSP4) in our provincial mathematics policy documents. Some recent hopeful and innovative models for professional learning that focuses the effective use of technology to support improved student learning will be highlighted.

Organizers: **M.-E. Caballero** (UNAM), **V. Pérez-Abreu** (UAM-Cuajimalpa) and **T. Salisbury** (York)

Thursday	Friday	Saturday
D. Dawson 11:30 - 12:20	*L. Gorostiza* 10:50 - 11:40	
	M. Boué 11:50 - 12:10	
J. A. López-Mimbela 12:30 - 12:50	*E. Rodrígues* 12:20 - 12:40	
E. Perkins 13:00 - 13:20	*B. Schmuland* 12:50 - 13:10	
	V. Pérez-Abreu 13:20 - 13:50	
B. Rémillard 16:00 - 16:20	*G. Ivanoff* 16:00 - 16:20	
D. Hernández 16:30 - 16:50	*V. Rivero* 16:30 - 16:50	
J. Walsh 17:00 - 17:20	*B. Virág* 17:00 - 17:20	
A. Meda 17:30 - 17:50	*M. E. Caballero* 17:30 - 17:50	

MICHELLE BOUE, Trent University, Ontario, Canada
[Friday September 22, 11:50]
Critical values for an epidemic model with moving particles

Kesten and Sidoravicius have recently introduced a spatial model for the spread of epidemics that takes into account the movement of individuals. We will discuss the phase transitions of this model and of some extensions that incorporate immunization and traps.

MARIA-EMILIA CABALLERO, Instituto de Matemáticas, UNAM, México
[Friday September 22, 17:30]
Conditioned stable Lévy processes and the ruin problem

In order to construct several interesting examples of Lévy processes, we work with the Lamperti transformation between Lévy processes and postive self-similar Markov processes.

By killing a stable Lévy process when it enters the positive half line, or by conditioning it to stay positive, or by conditioning it to hit 0 continuously, we obtain different positive self-similar Markov processes. We compute the infinitesimal generator of each of them and we also obtain, using the Lamperti's transformation, the corresponding Lévy processes and the characteristics of them.

As an application we obtain explicitly the law of the minimum before and independent exponential time, for some of these Lévy processes. This provides the explicit form of the spatial Wiener–Hofp factorization at a particular point and the value or the ruin probability for these processes.

This is based on a joint paper (to appear) with Loic Chaumont.

DONALD DAWSON, Carleton University, Canada
[Thursday September 21, 11:30]
Catalytic branching processes

A catalytic branching diffusion processes is a continuous state branching process in which the branching rate depends on the presence of a catalyst. A catalytic branching network corresponds to a multitype system in which some types serve as catalysts for other types. Catalytic branching networks in which there are closed cycles of catalytic types, perturbations of these, and catalytic systems distributed in space pose a number of challenging mathematical problems. In this lecture we discuss some aspects of these problems from the viewpoint of the hierarchical mean-field limit.

LUIS GOROSTIZA, CINVESTAV, México
[Friday September 22, 10:50]
Some questions on occupation times of branching systems

We consider occupation time fluctuations of (d, α, β)-branching systems. The long time rescaling limit processes have different properties in intermediate, critical and large dimensions (*e.g.*, long-range dependence vs. independent increments, path continuity vs. jumps), and questions arise on interpretation of results in terms of the systems.

DANIEL HERNÁNDEZ-HERNÁNDEZ, CIMAT, México
[Thursday September 21, 16:30]
Pricing, hedging and PDE's

In this talk we consider the mean-variance hedging problem when the market is incomplete. More specifically, we consider a stochastic volatility model, and study the problem using dynamic programming techniques. The nonlinear PDE involved in the solution is a parabolic quasi-linear equation with quadratic growth. Existence and uniqueness of classical solutions within a suitable class of smooth functions is obtained as well as relations with backward stochastic differential equations. Using these results an optimal hedging strategy is derived.

GAIL IVANOFF, University of Ottawa, Canada
[Friday September 22, 16:00]
Filtering of set-indexed stochastic processes

Multiparameter and set-indexed stochastic processes have many important applications in the natural sciences and engineering. The concept of stopping, which plays a fundamental role for processes indexed by the real line, is less well understood in this more general framework. We introduce the concept of adapted filtering as an appropriate generalization of stopping. Applications in areas such as multivariate survival analysis and multivariate precedence tests will be discussed.

J. ALFREDO LÓPEZ-MIMBELA, CIMAT, México
[Thursday September 21, 12:30]
Symmetric steady states of a semilinear equation with fractional Laplacian

We study a semilinear PDE equation whose evolution operator is the sum of a fractional power of the Laplacian and a convex non-linearity. By extending the method of moving planes to fractional powers of the Laplacian we prove that all positive steady states of the corresponding equation in a finite ball are radially symmetric.

ANA MEDA, Facultad de Ciencias, UNAM, México
[Thursday September 21, 17:30]
Estimates for the Value at Risk and ruin probabilities of diffusion processes with jumps

We have estimates for the tail distribution of $X_t^* = \sup_{0\leq s\leq t} X_s$, where X_s is a diffusion process with jumps which satisfies $X_s = m + \int_0^s \sigma_u \, dB_u + \int_0^s b_u \, du + \int_0^s \gamma_{u^-} \, d\tilde{N}_u$, where B is a Brownian motion; $\tilde{N}$ a compound Poisson process independent of B; b is an adapted integrable process; σ and γ are only assumed to be predictable—hence random, which encompasses all the stochastic volatility models. We discuss some applications to the estimation of a Dynamic Value at Risk and to the Ruin Probability of a risk process with stochastic investment.

VICTOR PÉREZ-ABREU, Universidad Autónoma Metropolitana–Cuajimalpa & CIMAT, México
[Friday September 22, 13:20]
Representation of Infinitely Divisible Distributions on Cones

In this talk we present a probabilistic characterization of cones in Fréchet spaces. Specifically, we show that a normal cone K in a Fréchet space is regular if and only if every infinitely divisible probability measure concentrated on K has the regular Lévy–Khintchine representation on cone.

This is joint work with Jan Rosinski.

EDWIN PERKINS, University of British Columbia, Canada
[Thursday September 21, 13:00]
Pathwise uniqueness for parabolic stochastic PDE's

Consider the SPDE: $du/dt = u" + g(u)dW/dtdx$ where $dW/dtdx$ is space-time white noise and g is Holder continuous of index h. It is shown that if $2h^3 - h > 3/4$ then pathwise uniqueness holds. The proof is an infinite dimensional extension of the Yamada–Watanabe Theorem.

This work is joint with Leonid Mytnik.

BRUNO RÉMILLARD, HEC Montréal, Canada
[Thursday September 21, 16:00]
TBA

VÍCTOR RIVERO, CIMAT, México
[Friday September 22, 16:30]
Recurrent extensions of positive self-similar Markov processes and Cramer's condition

Let $(X, \mathbb{P})$ be a positive self-similar Markov process that dies at its first hitting time of 0. In this work we study the existence and characterization of all positive valued self-similar Markov processes, $\widetilde{X}$, that behave like $(X, \mathbb{P})$ before its first hitting time of 0 and for which the state 0 is a regular and recurrent state. A such process $\widetilde{X}$ is called a recurrent extension of $(X, \mathbb{P})$. Our main result establishes that $(X, \mathbb{P})$ admits a self-similar recurrent extension that leaves 0 continuously if and only if the underlying Lévy process satisfies Cramer's condition.

ELIANE RODRIGUES, Instituto de Matemáticas, UNAM, México
[Friday September 22, 12:20]
A non-homogeneous Poisson model to estimate the number of ozone peaks in Mexico City

In this talk we consider the problem of estimating the number of exceedances of an air quality standard in a given period of time. A non-homogeneous Poisson model is proposed to analyse this issue. The rate at which the Poisson events occur is given by a rate function $\lambda(t)$, $t \geq 0$. This rate function also depends on some parameters that need to be estimated. Two forms for $\lambda(t)$, $t \geq 0$ are considered: Weibull and exponential-Weibull with parameters $\alpha \geq 0$, $\beta \geq 0$ and $\sigma \geq 0$, that will be estimated using a Bayesian formulation as well as a Gibbs sampling algorithm. The model is applied to the ozone data provided by the Mexico City monitoring network.

This is part of a joint work with Jorge A. Achcar from the University of São Paulo, Brazil, and A. A. Fernández-Bremauntz and G. Tzintzun both from the National Institute of Ecology of the Ministry of Environment, México.

BYRON SCHMULAND, University of Alberta, Edmonton, Alberta, Canada
[Friday September 22, 12:50]
Some recurrence sequences

We consider some generalizations of the renewal theorem for Markov chains. We will discuss both analytic and probabilistic approaches to finding the asymptotic behaviour of the solution of a renewal equation.

BALINT VIRAG, Toronto, Canada
[Friday September 22, 17:00]
TBA

JOHN WALSH, University of British Columbia, Vancouver, BC
[Thursday September 21, 17:00]
The Rate of Convergence of Numberical Solutions of SPDEs

Numerical solutions of stochastic differential equations are more often used to simulate the solutions than to find them, so the rate of convergence in distribution of numerical solutions is especially interesting. We will talk about the rates of convergence, both almost sure and in distribution, of various schemes, with emphasis on the stochastic wave equation.

Organizers: **A. Adem** (UBC), **J. González** (CINVESTAV), **I. Hambleton** (McMaster) and **D. Juan** (UNAM-Morelia)

Thursday	Friday	Saturday
	D. Juan Pineda 10:50 - 11:20	*G. Mikhalkin* 10:30 - 11:10
J. González 11:30 - 12:10	*A. Adem* 11:30 - 12:00	*M. Xicotencatl* 11:15 - 11:45
K. Lam 12:15 - 12:45	*E. Torres-Giese* 12:05 - 12:35	*J. Seade* 11:50 - 12:30
S. Gitler 12:50 - 13:30	*S. Antonyan* 12:45 - 13:15	
	R. Kane 13:20 - 13:50	
I. Hambleton 16:00 - 16:40	*E. Pedersen* 16:00 - 16:40	
E. Lupercio 16:45 - 17:15	*J. Mostovoy* 16:45 - 17:15	
J. Bryan 17:20 - 18:00	*J. L. Cisneros* 17:20 - 18:00	

ALEJANDRO ADEM, University of British Columbia, Canada
[Friday September 22, 11:30]
Commuting and non-commuting n-tuples in a Lie group

In this talk I will describe joint work with Fred Cohen on the geometry of the space of ordered commuting and non-commuting n-tuples in a Lie group G.

SERGEY ANTONYAN, Facultad de Ciencias, UNAM, México
[Friday September 22, 12:45]
Banach–Mazur compacta: Results and Problems

In his 1932 book *Théorie des Opérations Linéaires*, S. Banach introduced the space of isometry classes $[X]$, of n-dimensional Banach spaces equipped with the famous Banach–Mazur metric:

$$d([X],[Y]) = \ln \inf\big\{ \|T\| \cdot \|T^{-1}\| \;\big|\; T\colon X \to Y \text{ is a linear isomorphism}\big\}.$$

These spaces are now denoted by $BM(n)$ and called the Banach–Mazur compacta.

In this talk we shall present some resent results and open problems related to these interesting objects.

JIM BRYAN, University of British Columbia, Vancouver, Canada
[Thursday September 21, 17:20]
The Gromov–Witten invariants of orbifolds and their crepant resolutions

A well known principle in physics asserts that string theory on an orbifold X is equivalent to string theory on Y, any crepant resolution of X. Gromov–Witten theory is the mathematical counterpart of type IIA topological string theory and so it is expected that one can recover the Gromov–Witten invariants of Y from those on X. We will mathematically formulate and discuss this correspondence and illustrate it with some examples.

JOSE LUIS CISNEROS, Instituto de Matemáticas, UNAM, México
[Friday September 22, 17:20]
Characteristic classes and transversality

Let ξ be a smooth vector bundle over a differentiable manifold M. Let $h\colon \varepsilon^{n-i+1} \to \xi$ be a generic bundle morphism from the trivial bundle of rank $n-i+1$ to ξ. We give a geometric construction of the Stiefel–Whitney classes when ξ is a real vector bundle, and of the Chern classes when ξ is a complex vector bundle. Using h we define a differentiable closed manifold $\tilde{Z}(h)$ and a map $\phi\colon \tilde{Z}(h) \to M$ whose image is the singular set of h. The i-th characteristic class of ξ is the Poincaré dual of the image, under the homomorphism induced in homology by ϕ, of the fundamental class of the manifold $\tilde{Z}(h)$. We extend this definition for vector bundles over a paracompact space, using that the universal bundle is filtered by smooth vector bundles.

SAMUEL GITLER, CINVESTAV, México
[Thursday September 21, 12:50]
Moment angle complexes

Moment angle complexes are universal for toric varieties. There is a free action of a torus so that the quotient by this action gives you a toric manifold. We determine the stable structure of the moment angle complexes and their generalizations.

JESUS GONZÁLEZ, CINVESTAV, México
[Thursday September 21, 11:30]
Formal groups and BP-homology of finite abelian groups of rank two

In their study of differential periodic transformations, Conner and Floyd realized the importance of understanding the global structure of manifolds admitting a group action without stationary points. They succeeded in giving a homotopy characterization, but could only determine the corresponding bordism ideal for the case of a finite elementary abelian p-group of rank two (soon after the general rank case was completed by Floyd). In this talk I address the (2-primary) "non-elementary" situation. Much of the information is derived through a sharp description of the (simultaneous) 2- and v_1-divisibility properties of 2-typical formal groups. Although the geometric motivation is no longer valid, I discuss some applications to the motion planning and immersion problems for 2-torsion lens spaces.

This is joint work with Leticia Zárate.

IAN HAMBLETON, McMaster University, Canada
[Thursday September 21, 16:00]
Free actions on products of spheres

Which finite groups can act freely and smoothly on a product $S^n \times S^n$ of two spheres? This talk will describe an approach to solving this problem (joint work with Özgün Ünlü). Important test cases are the non-abelian p-groups of order p^3 and exponent p, for p an odd prime.

DANIEL JUAN PINEDA, Instituto de Matemáticas, UNAM, México
[Friday September 22, 10:50]
The Fibered Isomorphism Conjecture for braid groups

We will describe the Fibered Isomorphism Conjecture (FIC) of Farrell and Jones and show that the braid groups of the 2-dimensional sphere and the 2-dimensional real projective space in any number of strings satisfy FIC. We will present consequences of this fact in the computation of Whitehead group of the above groups.

RICHARD KANE, University of Western Ontario, Canada
[Friday September 22, 13:20]
Torsion and Lie Groups

The rational cohomology of a compact connected Lie group G can be expressed and explicitly determined using invariant theory. One need only determine the rational cohomology of BG, the classifying space of G, and that can be expressed as a ring of invariants determined by the action of the Weyl group W (associated to G) on the rational cohomology of BT, the classifying space of any maximal torus $T < G$.

When one moves to $\mathrm{mod}\, p$ cohomology the same pattern holds unless the group G has p torsion in its integral cohomology. In the torsion case one needs new tools and a new pattern. We will explore the use of the generalized invariants, as defined by Kac and Peterson, to address this question for both algebra and coalgebra structures.

KEE LAM, University of British Columbia, Vancouver, Canada
[Thursday September 21, 12:15]
On Yuzvinsky's conjecture arising from the study of sums of squares

An intercalate matrix M of type (r, s, n) is an r by s matrix each entry of which is colored by one of n given colors such that

(i) the colors along each row are mutually distinct, and likewise along each column,

(ii) any 2 by 2 submatrix of M contains either 2 colors or 4 colors.

Historically, interest in such matrices dated back to the classical work of Hurwitz and Radon on identities involving sums of squares. Let F be the field of 2 elements and P be the truncated polynomial ring $F[u, v]/(u^r, v^s)$, where (u^r, v^s) denotes the ideal generated by the r-th power of u and the s-th power of v. Let ros denote the "height" (or nilpotency) of $u + v$ as an element in P.

It was conjectured by S. Yuzvinsky that the number of colors required to make an r by s matrix intercalate must be at least ros. In this talk I will give a proof to some special cases of this conjecture. While combinatorial in content, the proof is suggested by, and is closely analogous to, ideas from topology and geometry. Bringing out such analogy as clearly as possible will be the main objective of my talk.

ERNESTO LUPERCIO, CINVESTAV, México
[Thursday September 21, 16:45]
Orbifold String Topology

In their seminal paper Chas and Sullivan introduced a new structure in the homology (and equivariant homology) of the free loop space of a smooth manifold. This structure behaves in many ways as a quantum field theory. For an algebraic topologist this has an expression as certain algebraic structures (BV-algebras, Lie algebras, operad actions). In this talk we will introduce the basic ideas in this field, and then explain our generalization (jointly with B. Uribe and M. Xicotencatl) to the case in which the manifold is replaced by an orbifold. An orbifold has an atlas which locally looks like an open set of euclidean space with the action of a finite group. Our generalization could be interpreted as an equivariant version of the theory.

GRIGORY MIKHALKIN, University of Toronto, Canada
[Saturday September 23, 10:30]
Tropical intersection theory

Tropical varieties are finite-dimensional polyhedral complexes which are in general not topological manifolds. However, it is possible to define cycles and the cycle intersections there. We plan to discuss these definitions as well as the tropical counterparts of $h^{p,q}$.

JACOB MOSTOVOY, Instituto de Matemáticas, UNAM, México
[Friday September 22, 16:45]
Moduli spaces of real curves

I will discuss various definitions of the moduli spaces of real algebraic curves.

ERIK PEDERSEN, Binghamton University, Binghamton, NY, USA
[Friday September 22, 16:00]
Manifolds and p-compact groups

We prove that every p-compact group is the p-completion of a smooth closed parallellisable manifold.

Joint work with Tilman Bauer.

JOSE SEADE, Instituto de Matemáticas, UNAM, México
[Saturday September 23, 11:50]
Open books and real analytic germs

Milnor's fibration theorem for complex singularities says that every holomorphic map $C^n \to C$ determines canonically an open book decomposition on the $2n-1$ sphere. This result has given rise to a vast literature, both in singularity theory and in knot theory.

In this talk I will present a recent work with Anne Pichon, where we extend Milnor's theorem to meromorphic germs and to certain real analytic mappings.

ENRIQUE TORRES-GIESE, University of British Columbia, Canada
[Friday September 22, 12:05]
Topology of Spaces of Homomorphisms

We will discuss basic geometric and homotopical properties of the space of homomorphisms $\mathrm{Hom}(\Gamma, G)$ when Γ is a suitable discrete group and G is a Lie group.

MIGUEL XICOTENCATL, CINVESTAV, México
[Saturday September 23, 11:15]
The loop orbifold of the symmetric product

By using the loop orbifold of the symmetric product, we give a formula for the Poincaré polynomial of the free loop space of the Borel construction of the symmetric product. We also show that the Chas–Sullivan product in the homology of the free loop space of the Borel construction induces a ring structure in the homology of the inertia orbifold of the symmetric product. This ring structure is compared to the one in cohomology through Poincaré duality.

Room K6 **Variational Methods in Partial Differential Equations**

Organizers: **L. Bronsard** (McMaster) and **P. Padilla** (IIMAS-UNAM)

Thursday	Friday	Saturday
	R. Choksi 10:50 - 11:10	*N. Ghoussoub* 10:30 - 10:50
	A. Minzoni 11:20 - 11:40	*M. Rocha* 11:00 - 11:20
	I. Ekeland 11:50 - 12:10	*L. Bronsard* 11:30 - 11:50
	P. Panayotaros[b] 12:20 - 12:40 [b]Part I, see page 40	*P. Padilla* 12:00 - 12:30
	W. Craig 12:50 - 13:10	
	H. Lomelí 13:20 - 13:50	
	N. Kamran 16:00 - 16:20	
	H. Sánchez Morgado 16:30 - 16:50	
	A. Montero Zárate 17:00 - 17:20	
	R. Iturriaga 17:30 - 18:00	

LIA BRONSARD, McMaster University, Hamilton, ON, Canada
[Saturday September 23, 11:30]
Vortices for a rotating toroidal Bose–Einstein condensate

We construct local minimizers of the Gross–Pitaevskii energy, introduced to model Bose–Einstein condensates (BEC) in the Thomas–Fermi regime which are subject to a uniform rotation. Our sample domain is taken to be a solid torus of revolution in $\mathbf{R}^3$ with starshaped cross-section. We show that for angular speeds $\omega_\epsilon = O(|\ln \epsilon|)$ there exist local minimizers of the energy which exhibit vortices, for small enough values of the parameter ϵ. These vortices concentrate at one or several planar arcs (represented by integer multiplicity rectifiable currents) which minimize a line energy, obtained as a Γ-limit of the Gross–Pitaevskii functional. The location of these limiting vortex lines can be described under certain geometrical hypotheses on the cross-sections of the torus.

These are results obtained in collaboration with S. Alama and J. A. Montero.

RUSTUM CHOKSI, Simon Fraser University, Canada
[Friday September 22, 10:50]
Scaling laws during the onset and destruction of the intermediate state in a type-I superconductor

The intermediate state of type-I superconductors is a classical pattern-formation problems in physics, first studied by Landau in 1937. Here we explore the ground state energy from the point of view of rigorous scaling laws. We find precisely five parameter regimes each associated with an optimal construction and scaling law, thereby proving that exactly those five different regimes are traversed with increasing magnetic field.

This is joint work with Sergio Conti (Duisburg–Essen), Bob Kohn (Courant) and Felix Otto (Bonn).

WALTER CRAIG, McMaster University, Hamilton, ON, Canada
[Friday September 22, 12:50]
Remarks on the singular set of solutions of the Navier–Stokes equations

This presentation will discuss several results on the space-time set of singlarities of (energy inequality satisfying) weak solutions of the Navier–Stokes equations.

This is recent joint work with A. Biryuk and S. Ibrahim.

IVAR EKELAND, University of British Columbia, Canada
[Friday September 22, 11:50]
A new type of differential equation arising from economic theory

In optimal control, the discount rate is always exponential, that is, a gain of u occurring at a distance (in time) t from now is worth a gain $u\exp(-rt)$ today, where $r > 0$ is the interest rate. Using this expression, one derives the classical Hamilton–Jacobi–Bellman equation.

In economics, there is no reason to favour exponential discount rates. Much interest recently has been paid to discount rates $h(t)$, where $h(0) = 1$, h is decreasing and $h(t)$ goes to zero when t goes to infinity. With such a discount rate, the optimal control loses economic significance, and must be replaced by an equilibrium strategy. The latter is given by a new equation, which resembles the HJB equation, but which is no longer a PDE.

NASSIF GHOUSSOUB, University of British Columbia, Canada
[Saturday September 23, 10:30]
On PDEs arising from Electrostatic Micro-Electromechanical Systems

We analyze the nonlinear parabolic problem $u_t = \Delta u - \frac{\lambda f(x)}{(1+u)2}$ on a bounded domain Ω of $\mathbb{R}^N$ with Dirichlet boundary conditions. This equation models a simple electrostatic Micro-Electromechanical System (MEMS) device consisting of a thin dielectric elastic membrane with boundary supported at 0 above a rigid ground plate located at -1. When a voltage—represented here by λ—is applied, the membrane deflects towards the ground plate and a snap-through may occur when it exceeds a certain critical value λ^* (pull-in voltage). This creates a so-called "pull-in instability" which greatly affects the design of many devices. The challenge is to estimate λ^* in terms of material properties of the membrane, which can be fabricated with a spatially varying dielectric permittivity profile f. Applying analytical and numerical techniques, the existence of λ^* is established together with rigorous bounds. We show the existence of at least one steady-state when $\lambda < \lambda^*$ (and when $\lambda = \lambda^*$ in dimension $N \leq 7$) while none is possible for $\lambda > \lambda^*$. More refined properties of steady states—such as regularity, stability, uniqueness, multiplicity, energy estimates and comparison results—are shown to depend on the dimension of the ambient space and on the permittivity profile.

As to the dynamic case, the membrane globally converges to its unique maximal negative steady-state when $\lambda \leq \lambda^*$, with a possibility of touchdown at infinite time when $\lambda = \lambda^*$. On the other hand, if $\lambda > \lambda^*$ the membrane must touch down at finite time T, and touchdown cannot take place at the location where the permittivity profile vanishes. Both larger pull-in distance and larger pull-in voltage can be achieved by properly tailoring the permittivity profile. We analyze and compare finite touchdown times by applying various analytical and numerical techniques.

This is joint work with Yujin Guo.

RENATO ITURRIAGA, CIMAT, México
[Friday September 22, 17:30]
Physical solutions of the Hamilton–Jacobi equation

We consider a Lagrangian system on the d-dimensional torus, and the associated Hamilton–Jacobi equation. Assuming that the Aubry set of the system consists in a finite number of hyperbolic periodic orbits of the Euler–Lagrange flow, we study the vanishing-viscosity limit, from the viscous equation to the inviscid problem. Under suitable assumptions, we show that solutions of the viscous Hamilton–Jacobi equation converge to a unique solution of the inviscid problem.

NIKY KAMRAN, McGill University, Montreal, Canada
[Friday September 22, 16:00]
Conserved energy and the Teukolsky equation

The Teukolsky equation is a linear hyperbolic second order pde which governs the propagation of scalar, electromagnetric and gravitational waves in the Kerr solution of the Einstein equations. (The Kerr metric describes the space-time geometry of a rotating black hole in equilibrium.) A long-standing open problem, which amounts to the stability question for the Kerr black hole, is to show that the solutions of the Teukolsly equation decay as t tends to infinity. This has now been proved for scalar waves, but the higher spin case is still open. Even the apparently simple task of constructing a conserved energy for the Teukolsky equation which is positive outside the ergosphere is a non-trivial exercise, which requires the introduction of Debye potentials. I will review some recent work on this problem done in collaboration with Felix Finster, Joel Smoller and Shing-Tung Yau, and outline some perspectives.

HECTOR LOMELÍ, Instituto Tecnológico Autónomo de México, México
[Friday September 22, 13:20]
Invariant manifolds, variational principles and dynamic programming

The optimality principle of Bellman is frequently used to solve problems in dynamic programming. The optimal selection of the dynamic control is the optimal policy. The method of Bellman leads to the so-called Hamilton–Jacobi–Bellman PDE.

An important observation is that there are areas of dynamics that use variational methods similar to the one of Bellman. In particular, it is possible to use a variational principle to approximate and study the stable and unstable manifolds of a saddle fixed point. In this work we explore the dynamic properties of the principle of Bellman.

ANTONMARIA MINZONI, IIMAS, UNAM, México
[Friday September 22, 11:20]
Stability of embedded solitons at the edge of the continuum

We consider the problem of two hump solutions of the modified NLS equation which describes short optical pulses.

Multihump solutions are obtained asymptotically using a modulation formulation on the Lagrangian coupled to a free boundary for the radiation. We study the one sided stability using the modulation coupled with the radiation.

The effects which produce the multiple humps and their instabilty are exponentially small in the distance between humps.

We show that the asymptotic theory explains completely the numerics in the dynamical evolution.

We commment on the possibility of making rigorous this asymptotic theory.

ALBERTO MONTERO ZÁRATE, University of Toronto, Canada
[Friday September 22, 17:00]
A Gamma convergence result for the Gross Pitaevskii energy in $\mathbb{R}^3$

The Gross Pitaevskii energy is a functional often used to model Bose Einstein condensates trapped in a potential. We consider this energy in all of $\mathbb{R}^3$, under a mass constraint, and find its gamma limit as a certain parameter in the energy goes to infinity. Among other things this requires a (to the best of my knowledge) new regularity result for elliptic equations in a bounded, smooth domain that loose ellipticity on the boundary.

PABLO PADILLA, IIMAS, UNAM, México
[Saturday September 23, 12:00]
A dynamical systems approach to symmetry in PDE's

We present a dynamical systems framework to obtain symmetry properties of partial differential equations with variational structure based on energy estimates. Comparisons with other methods, *e.g.* moving planes, symmetrization techniques, *etc.*, are also discussed.

PANAYOTIS PANAYOTAROS, IIMAS, UNAM, México
[Friday September 22, 12:20]
Localized invariant tori in the discrete NLS with diffraction management

We present results on the existence of localized invariant tori solutions in a discrete NLS equation with periodic parametric forcing. The equation models a system of coupled waveguide arrays with a special geometry that reduces diffraction effects. The solutions are obtained by continuing breather periodic solutions of an approximate autonomous system. We review some results on localized and multipeak solutions of this system and sketch a continuation argument that is based on general ideas on the continuation of invariant tori in Hamiltonian systems with symmetries.

MARIANITO ROCHA, Instituto Tecnológico Autónomo de México, México
[Saturday September 23, 11:00]
Approximate monotonic traveling wave solutions to reaction-diffusion systems with general nonlinearities

We propose a simple variational approach to obtain approximate analytical expressions for monotonic traveling wave solutions of coupled reaction-diffusion systems with general nonlinearities.

Joint work with Robert Miura, New Jersey Institute of Technology.

HÉCTOR SÁNCHEZ MORGADO, Instituto de Matemáticas, UNAM, México
[Friday September 22, 16:30]
Hyperbolicity and exponential convergence of the Lax Oleinik semigroup

Consider a convex superlinear Lagrangian $L\colon TM \to \mathbb{R}$ on a compact manifold M. It has been shown that there is a unique number c such that the Lax Oleinik semigroup $\mathcal{L}_t\colon C(M,\mathbb{R}) \to C(M,\mathbb{R})$ defined by

$$\mathcal{L}_t v(x) = \inf\left\{ v\big(\gamma(0)\big) + \int_0^t L(\gamma,\dot\gamma) + ct : \gamma\colon [0,t] \to M \text{ is piecewise } C^1, \gamma(t) = x \right\}$$

has a fixed point. Moreover for any $v \in C(M,\mathbb{R})$ the uniform limit $\tilde v = \lim_{t\to\infty} \mathcal{L}_t v$ exists.

Theorem 1 *Assume that the Aubry set consists in a finite number of hyperbolic periodic orbits or critical points of the Euler–Lagrange flow. Then, there is $\mu > 0$ such that for any $v \in C(M,\mathbb{R})$ there is $K > 0$ such that*

$$\|\mathcal{L}_t v - \tilde v\|_u \le K e^{-\mu t} \quad \forall t \ge 0.$$

We believe the reciprocal holds but for the moment we only have the proof for a mechanical Lagrangian.

Theorem 2 *Let* $L\colon TM \to \mathbb{R}$ *given by* $L(x,v) = \frac{1}{2}v^2 - V(x)$ *with*

$$\max_x V(x) = c, \quad V^{-1}(c) = \{x_1, \ldots, x_m\}.$$

Suppose that there is $\mu > 0$ *such that for any* $v \in C(M, \mathbb{R})$ *there is* $K > 0$ *such that*

$$\|\mathcal{L}_t v - \tilde{v}\|_u \leq K e^{-\mu t} \quad \forall t \geq 0.$$

Then $(x_i, 0)$, $i = 1, \ldots m$ *is a hyperbolic critical point of the Euler–Lagrange flow.*