Student Poster Session
Séance d'affiches étudiantes
(Org: **Simon Huang and Svenja Huntemann** (Studc))

ISMAIL ABOUAMAL, Université de Montréal
A fifth-order quantum superintegrable system and its relation with the Painlevé property.

We consider a two dimensional quantum Hamiltonian in Cartesian coordinates and its coexistence with a fifth-order integral of motion. We impose the superintegrablity condition and find explicitly all exotic superintegrable potentials allowing the existence of such an integral. All of these potentials are found to have the Painlevé property and some of them are expressed in terms of Painlevé transcendents and elliptic functions.

JEOVANNY DE JESUS MUENTES ACEVEDO, Universidade de Sao Paulo
On the Continuity of the Topological Entropy of Non-autonomous Dynamical Systems

Let M be a compact Riemannian manifold. The set $\mathsf{F}^r(M)$ consisting of sequences $(f_i)_{i\in\mathbb{Z}}$ of C^r-diffeomorphisms on M can be endowed with the compact topology or with the strong topology. A notion of topological entropy is given for these sequences. I will prove this entropy is discontinuous on each sequence if we consider the compact topology on $\mathsf{F}^r(M)$. On the other hand, if $r \geq 1$ and we consider the strong topology on $\mathsf{F}^r(M)$, this entropy is a continuous map.

SADIA ANSARI, Loyola University Chicago
Minimal Generating Sets of the Symmetric Group

The goal of this project is to analyze the minimal generating sets of the symmetric group S_n. To accomplish the task, we first build all of them for S_3 through S_5. We use group automorphisms and cycle-type to facilitate this. Specifically, we organize our search for minimal generating sets by the cycle-types of its elements, and we identify any such X with any of its images under conjugation. As such, "orbit size" becomes the first interesting aspect of the project. Given a minimal generating set X from an orbit, we construct the rooted tree such that each node is an element w of S_n. Its path to the root represents a shortest expression for w in terms of the generators. The properties (such as depth and width) of such trees, uniqueness up to automorphism, the posets of minimal generating sets not of the form $\{(1,2),(2,3),\ldots,(n-1,n)\}$, and the minimal generating sets (for $n = 3, 4, 5$) that fit into a family for any $n \geq 3$ are studied. (Preliminary report of work started under the auspices of the McNair program at Loyola Chicago.)

AHMED ASHRAF, Western University
Combinatorial Characters of Symmetric Group

We derive an expression for generating function of irreducible character of $\mathfrak{S}_n$ corresponding to two row partition $(n-k,k)$ and hook partition $(n-k,1^k)$ in terms of cycle statistics of evaluating permutation. We use Doubilet inversion formula and homology of poset of tilings for our derivation. As an application we give a new proof of M. Rosas formula for Kronecker coefficients of two row partition and hook partition.

HÉCTOR BARGE, Universidad Politécnica de Madrid
Topology and dynamics of quasi-attractors and IFS attractors

In this poster some results about quasi-attractors of flows and attractors of IFS (Iterated Function Systems) are presented. For instance, we show that every compact subset of the Euclidean space is a quasi-attractor of some flow and that every attractor of a contractive and invertible IFS has either trivial shape or the shape of the hawaaian earring, provided that it has empty interior. All the results presented have been obtained in collaboration with Antonio Giraldo and José M.R. Sanjurjo.

BRUNO COSTA, University of São Paulo
Symmetries and Lie groupoids

Starting from a given action of a Lie groupoid on a fiber bundle, we show how to construct induced actions of certain Lie groupoids, derived from the original one, on certain fiber bundles, derived from the original one: this is an essential technical feature needed to understanding what it meant by invariance of a tensor field under the action of a Lie groupoid. As the most important example, we are able to show in which sense the multicanonical form θ and the multisymplectic form ω of the covariant hamiltonian formalism are invariant under the appropriate induced action, and similarly, the forms $\theta_{\mathcal{H}}$ and $\omega_{\mathcal{H}}$, given by the pull-back of the forms θ and ω by the hamiltonian $\mathcal{H}$, respectively, are invariant under the action of a Lie groupoid leaving the hamiltonian invariant. This is a joint work with Frank Michael Forger (University of São Paulo).

GARCIA GALLEGOS MONICA DEL ROCIO, Univesité du Québec à Montréal (UQÀM)
Stability Conditions and Non Crossing Tree Partitions

Noncrossing tree partitions were introduced by Garver and McConville to obtain an explicit description of the wide subcategories in the module category of a family of representation finite gentle algebras. Very recently, it was proven by Yurikusa that for any finite dimensional algebra of finite representation type its wide subcategories are realizable as semi-stable subcategories in the sense of King. Our goal is to provide a combinatorial construction of Yurikusa's stability conditions for the wide subcategories defined by noncrossing tree partitions. This project is the result of a Mitacs Globalink Research Internship hosted by UQAM.

BRUNA CASSOL DOS SANTOS, Institute of Mathematics and Statistics - University of São Paulo
Qualitative study for a vector-borne epidemic model

Many efforts have been made trying to describe the dynamic of infectious diseases and with the intention to identify which parameters have the most epidemiological importance. We study a classical SIR-SI model for arboviruses considering a variance in the size of human population. Under this hypothesis, we developed a qualitative study of the mathematical model analysing the local and global stability of the equilibrium. The disease-free equilibrium is globally stable if $Ro \leq 1$ and unstable if $Ro > 1$. For the endemic equilibrium we showed that if $Ro > 1$ then this equilibrium is globally stable. The results of the global stability were verified by using the Poincaré Bendixson criterion for competitive systems. Finally we take a sensitivity analysis with the aim to identify the most important parameters in the disease's spread through the Ro parameter, and the prevalence of the disease through the endemic equilibrium sensitivity. We found that the bite rate and the mortality rate of the vector are the most sensitive parameters.

RAMIRO PEÑAS GALEZO, Universidad del Atlántico
Mathematical model of coupled elasto plastic membranes

We present the partial differential equations of a model of two flat elastoplastic membranes, of different material, coupled, with tensions and deformations parallel to the plane. The variational formulation of the coupled problem uses the development of Matthias Liero and Alexander Mielke on elasto plastic plates. The existence and uniqueness of solutions is demonstrated by the Lax-Milgram theorem.

ZOFIA GRABOWIECKA, Université de Montréal
Subsymmetry decomposition of H_3 polytopes

Polytopes of non-crystallographic Coxeter group in 3D are considered. The method of decorating Coxeter-Dynkin diagrams, which allows to describe polytopes in all dimensions is presented. The method of decomposing vertices of H_3 polytopes into orbits of lower symmetry groups is explained. The decomposition is provided for polytopes with 60 vertices.

SARAH MALICK, Clemson University
A connection between grad-div stabilized FE solutions and pointwise divergence-free FE solutions on general meshes

We prove, for Stokes, Oseen, and Boussinesq finite element discretizations on general meshes, that grad-div stabilized Taylor-Hood velocity solutions converge to the pointwise divergence-free solution (found with the iterated penalty method) at a rate of γ^{-1}, where γ is the grad-div parameter. However, pressure is only guaranteed to converge when $(X_h, \nabla \cdot X_h)$ satisfies the LBB condition, where X_h is the finite element velocity space. For the Boussinesq equations, the temperature solution also converges at the rate γ^{-1}. We provide several numerical tests that verify our theory. This extends work that required special macroelement structure in the mesh.

SANTIAGO MILER QUISPE MAMANI, Universidade de Brasilia
Torsion Free Modules Decomposition as Direct Sum of Modules with Rank 1

The aim of this paper is to present the result given by Bass in [1], which determines a condition on the integral domain R so that every finitely generated torsion free module is written as a direct sum of modules of rank 1. We show that a necessary condition is that all ideal in R is generated by two elements, in other words, that these domains are almost Dedekind domains. Then, we apply the result in the description of torsion free modules of finite rank over the coordinate rings of singular curves, whose singularities are nodal or cuspidal. Key-words: Torsion free modules. Modules of rank 1. Nodal and Cuspidal.

[1] BASS, H. Torsion free and projective modules, Trans. Amer. Math. Soc.102, p. 319-327, 1962.

MASOUMEH SAJEDI, Universite de Montreal
Fourth order Superintegrable systems separating in Cartesian coordinates- Exotic quantum potentials

We consider two-dimensional quantum Superintegrable Hamiltonians with separation of variables in Cartesian coordinates. We focus on systems that allow fourth-order integrals of motion, also potentials satisfying nonlinear ODEs with the Painlevé property. We classify all potentials expressed in terms of Painlevé transcendents and their integrals.

BEATRIZ MOLINA-SAMPER, UNIVERSITY OF VALLADOLID
Combinatorial Maximal Contact Theory

Hironaka's characteristic polyhedra represent the combinatorial steps in almost any procedure of reduction of singularities. This is implicit in Hironaka's formulation of the polyhedra game. The main arguments to solve the combinatorial part for the reduction of singularities are contained in Spivakovsky's solution to Hironaka's game. On the other hand the globalization of the strategies as well as the geometrical structure of the induction to obtain reduction of singularities are the main ideas in the Maximal Contact Theory, developed by Hironaka, Aroca and Vicente for the case of complex analytic spaces. We present here a way of considering the combinatorial problems in terms of Systems of Newton Polyhedra and Characteristic Polyhedra. In this formulation, the combinatorial features of the problems are reflected without loosing the global aspects. We give a solution of the problem following the classical lines and in particular we need to project the problem over a "Maximal Contact Support Fabric" that plays the role of the maximal contact variety. This combinatorial structure is free of restrictions on the characteristic and can be applied simultaneously to varieties, foliations, vector fields and differential forms among other possible objects.

MARIIA MYRONOVA, Université de Montréal
Dynamical generation of graphene

In recent decades, the astonishing physical properties of carbon nanostructures have been discovered and are nowadays intensively studied. We introduce how to obtain a graphene sheet using group theoretical methods and how to construct a graphene layer using the method of dynamical generation of quasicrystals. Both approaches can be formulated in such a way that the points of infinite graphene sheet are generated. Moreover, they provide identical graphene layers. The main objective is to

describe how to generate graphene step by step from a single point of the Euclidean plane $\mathbb{R}^2$. Some 2D examples will be shown.

PAVEL ZENON SEJAS PAZ, University of Brasília
EM heating stimulated water flooding for medium-heavy oil recovery

We report a study of heavy oil recovery by combined water flooding and electromagnetic (EM) heating at a frequency of 2.54 GHz used in domestic microwave ovens. A mathematical model describing this process was developed. Model equations were solved and the solution is presented in an integral form for the one dimensional case. Experiments consisting of water injection into Bentheimer sandstone cores, either fully water-saturated or containing a model heavy oil, were also conducted, with and without EM heating.

Model prediction is found to be in rather good agreement with an experiments. EM energy was efficiently absorbed by water and, under dynamic conditions, was transported deep into the porous medium. The amount of EM energy absorbed increase with water saturation. Oil recovery by water flooding combined with EM heating was up to 37.0% larger than for cold water flooding. These observations indicate that EM heating induces an overall improvement of the mobility ratio between the displacing water and the displaced heavy oil.

CARLOS VALERO, University of Waterloo
Separation of Variables on Spaces of Constant Curvature

Given a pseudo-Riemannian manifold (M, g), an important and ubiquitous partial differential equation one can define is the Laplace-Beltrami equation

$$g^{ij}(q)\nabla_i\nabla_j\psi + V(q)\psi = E\psi$$

which reduces to the Schrodinger equation in the Riemannian case, and a (generalized) wave equation in the Lorentzian case. Separation of variables is an old but powerful method for obtaining exact solutions to this equation, but it is not always possible. So the question we address is the following: how can we determine and classify the coordinate systems on M which admit a separable solution of the Laplace-Beltrami equation? We restrict ourselves to spaces of constant curvature, in which the theory of conformal Killing tensors yields an efficient and exhaustive approach to this problem. We review some of the recent work done on this problem, highlighting interesting results, and focusing on the much more interesting Lorentzian cases, which include Minkowski, de Sitter, and anti-de Sitter spaces.

FELIPE YUKIHIDE YASUMURA, State University of Campinas
Gradings on upper triangular matrices and their graded automorphisms

It is well known that every automorphism of a central simple associative algebra is inner. The same statement was proved to be true for the associative algebra of upper triangular matrices. Similar questions can be raised for algebras with additional structure, for example, in the context of graded algebras. Recently, graded algebras constitute a subject of intense investigation, due to its naturalness in Physics and Mathematics. The polynomial algebras (in one or more commutative variables) are the most natural structure of an algebra with a grading - given by the usual degree of polynomials. For instance, the classification of finite dimensional semisimple Lie algebras gives rise to naturally $\mathbb{Z}^m$-graded algebras. Kemer solved a very difficult problem known as the Specht property in the theory of algebras with Polynomial Identities in the setting of associative algebras over fields of characteristic zero, using $\mathbb{Z}_2$-graded algebras as a tool. After the works of Kemer, interest in graded algebras increased greatly.

In this poster, we present all the gradings on the algebra of upper triangular matrices and show the self-equivalences, the graded automorphisms, the Weyl and diagonal groups, considered as associative, Lie and Jordan algebras. We also cite their graded involutions on the associative case.

AHMED ZEROUALI, University of Toronto
Duistermaat-Heckman Measure of a Twisted q-Hamiltonian Space

A q(uasi)-Hamiltonian G-space (M, ω, Φ) can be viewed as a generalization of a symplectic manifold with a Hamiltonian action of a Lie group G, where one has an Ad-equivariant group-valued moment map $\Phi : M \to G$, along with an invariant 2-form ω on M satisfying a minimal degeneracy condition and whose differential is the pullback of the Cartan 3-form on G. As in the symplectic setup, a q-Hamiltonian space has a notion of Liouville form, and its push-forward under the moment map defines a Duistermaat-Heckman (DH) measure on the Lie group G that encodes the volumes of "symplectically" reduced spaces.

Building on work of Alekseev, Bursztyn and Meinrenken, we give a characterization of the DH measure of a twisted q-Hamiltonian G-space. This is a generalization in which the moment map Φ is equivariant with respect to twisted conjugation: $\mathrm{Ad}_g^{(\tau)}(h) = g \cdot h \cdot \tau(g^{-1})$ for $g, h \in G$, where τ is a Dynkin diagram automorphism. Our main result is a localization formula for the Fourier coefficients of the DH measure, and we illustrate its use with examples relevant to Lie theory and mathematical physics.