Random Walks and Geometry
Marches aléatoires et géométrie
(Org: **Giulio Tiozzo** (ICERM, Brown University))

LOUIS-PIERRE ARGUIN, Université de Montréal
Distributions of the maxima of the two-dimensional Gaussian free field

The two-dimensional Gaussian free field is a model of a random surface whose correlations are given by the Green's function of the simple random walk. In this talk, I will present recent results by several authors in understanding the statistics and the geometry of the maxima of this random surface. The results strongly suggest that the maxima of the model behave similarly as fields in a broad universality class, the so-called log-correlated fields. In particular, I will highlight the close connection with the maxima of branching Brownian motion.

MOHAMMAD BARDESTANI, University of Ottawa
Representation theory of profinite groups and its application in group expansion

We will provide some results on the minimal dimension of continuous representation of some profinite groups, and we apply these bounds to study some questions in the theory of group expansion.

IAN BIRINGER, Boston College
Random limits of Riemannian manifolds

We will promote a convenient limiting object for a sequence of closed, Riemannian manifolds, inspired by Benjamini-Schramm convergence in graph theory.

JAN CANNIZZO, University of Ottawa
Poisson bundles and boundary actions

The study of conjugation-invariant measures on the space of subgroups of a given finitely generated group (also known as invariant random subgroups) has attracted a significant amount of attention in recent years. We introduce an approach to studying invariant random subgroups based on Poisson bundles, which are the objects obtained by attaching to a random subgroup the Poisson boundary of the random walk on its Schreier coset graph. Our main result is that the boundary action of an invariant random subgroup is conservative (there are no wandering sets). This is joint work with Vadim Kaimanovich.

RENATO FERES, Washington University
Random dynamical systems of billiard type

Billiard systems, broadly understood, are Hamiltonian systems on manifolds with boundary. When some of the dynamical variables are assumed random and kept at a fixed statistical state, we are led to consider Markov chains whose stochastic dynamics reflect the underlying geometric features of the system. This talk will focus on the interplay between geometry and the diffusion properties of (limits of) Markov chains derived from billiard systems. It will also indicate how such systems can help illuminate the foundations of stochastic thermodynamics.

BEHRANG FORGHANI, University of Ottawa
Transformation of random walks on groups via Markov stopping times

We describe a new construction of a family of measures on a group with the same Poisson boundary. Our approach is based on applying Markov stopping times to an extension of the original random walk.

VAIBHAV GADRE, University of Warwick
Lyapunov expansion exponent for non-uniform lattices in $SL(2,\mathbb{R})$.

Given a finitely generated group G of circle diffeomorphisms with a choice of a generating set and a point x in S^1, Deroin-Kleptsyn-Navas defined the Lyapunov expansion exponent of G at x. In joint work with J. Maher and G. Tiozzo, we show that when G is a non-uniform lattice in $SL(2,\mathbb{R})$ the Lyapunov expansion of G is zero at almost every x. This answers a question of theirs.

ILYA GEKHTMANN, University of Chicago
Stable type of the mapping class group

The stable ratio set is a notion introduced by Bowen and Nevo to prove pointwise ergodic theorems for certain nonamenable groups. I use statistical hyperbolicity of Teichmueller space and techniques from Patterson-Sullivan theory to prove that the stable ratio set of the mapping class group acting on PMF with the Thurston measure contains numbers that are not 0, 1 or infinity.

MARYAM HOSSEINI, university of ottawa
Extensions of Cantor Minimal Systems.

Using the spectrum of Cantor minimal systems and Dimension groups we will show that any non-wealky mixing Cantor minimal system is orbit equivalent to an almost automorphic system. This is a joint work with David Handelman and Thierry Giordano.

ARASH JAMSHIDPEY, university of Ottawa
The geometric median of samples from measures induced by simple random walks

A geometric median or Fermat point of a finite subset A of a metric space (S,d) is simply a point of the space that minimizes the total distance to points of A, i.e. $d(x,A) := \sum_{a\in A} d(x,a)$. A set of points may have more than one median. The total distance of a median of A to A is called the median value.

Using some natural measures arising from simple random walks, tree indexed random walks and the uniform measure, we sample points from some discrete metric spaces. Both problems of small and large sampling will be considered. Our goal is to study the median of the sample data. In some cases, the median in an asymptotic geometry will be discussed. In particular, defining the asymptotic tree indexed random walk, we will see some examples of metric spaces for which after a convenient rescaling of the metric there are some median points in the trajectories of the tree indexed random walk asymptotically almost surely.

MICHAEL KOZDRON, University of Regina
A random walk proof of the matrix tree theorem

The matrix tree theorem, also called Kirchhoff's theorem after the 19th century German physicist Gustav Kirchhoff, relates the number of spanning trees in a graph to the determinant of a matrix derived from the graph. Although there are a number of proofs of Kirchhoff's theorem known, most are combinatorial in nature. In this talk we will present a relatively elementary random walk-based proof of Kirchhoff's theorem which follows from Greg Lawler's proof of David Wilson's 1996 algorithm for generating spanning trees uniformly at random. Since Wilson's algorithm is interesting in its own right and easily understood, we will spend some time discussing his technique for generating uniform spanning trees. As a curious side note, most other algorithms for generating spanning trees do not yield the matrix tree theorem as a consequence; Wilson's algorithm does! Moreover, these same ideas can be applied to other computations related to general Markov chains and processes on a finite state space. Based on joint work with Larissa Richards (Toronto) and Dan Stroock (MIT).

JOSEPH MAHER, CUNY College of Staten Island
The Casson invariant of random Heegaard splittings

The mapping class group element resulting from a finite length random walk on the mapping class group may be used as the gluing map for a Heegaard splitting, and the resulting 3-manifold is known as a random Heegaard splitting. We use these to show the existence of closed hyperbolic 3-manifolds of arbitrarily large volume with any given value of the Casson invariant. This is joint work with Alexander Lubotzky and Conan Wu.

IGOR RIVIN, Temple University
Generic and random elements

I will describe some definitions of random elements in interesting groups and ways to generate them.

PAUL SCHUPP, University of Illinois at Urbana-Champaign
From random walks to coarse computability

The paper "Generic-case Complexity, Decision Problems in Group Theory and Random Walks" by Kapovich, Myasnikov, Schupp and Shpilrain considered how difficult problems are on "generic" or "random" inputs. Here one has a partial algorithm which is always correct if it answers but it may fail to answer on a "very small" set of inputs. Another natural model of "imperfect computation" is that of "coarse computability". Here one has a total algorithm which always answers but which may be wrong on a "very small" set of inputs. In this talk I will outline some of the fruitful interaction of thses ideas with classical computability theory.

ALESSANDRO SISTO, ETH Zurich
Tracking rates of random walks

Examples of relatively hyperbolic groups include fundamental groups of finite volume negatively curved manifolds, many fundamental groups of 3-manifolds, limit groups and many others. I will discuss the result that simple random walks on nontrivial relatively hyperbolic groups stay $O(\log(n))$ close to geodesics with high probability, where n is the number of steps of the walk. Similarities between the geometry of relatively hyperbolic groups and that of mapping class groups allow to show a similar result for mapping class groups, with rate $O(\sqrt{n\log(n)})$.

ALDEN WALKER, University of Chicago
Surface subgroups

I'll describe some recent results showing that there exist many surface subgroups of random graphs of free groups and random groups. These proofs use a combinatorial construction which relies on properties of Markov processes. This is joint work with Danny Calegari, and I'll talk about results of Danny Calegari and Henry Wilton.