

“Geometry and Dynamics”

November 10 - 14, 2025

Tata Institute of Fundamental Research, Mumbai

LECTURE SCHEDULE

Lecture Timings	Monday (10 November)	Tuesday (11 November)	Wednesday (12 November)	Thursday (13 November)	Friday (14 November)
10:00 – 11:00	Radhika Gupta (AG-66)	Sanju Velani (AG-66)	Henna Koivusalu (AG-66)	School Visit	Natalia Jurga (AG-66)
11:00 – 11:30	TEA BREAK				
11:30 – 12:30	Macarena Arenas (AG-66)	Mahesh Kakde (AG-66)	Subhadip Dey (AG-66)	School Visit	Mahan Mj (AG-66)
12:30 – 02:30	LUNCH				
02:30 – 03:30	Subhojoy Gupta (AG-66)	Jens Marklof (AG-66)	Women in Maths (2:30 – 4:00) (AG-66)	Martin Bridson (AG-66)	–
03:30 – 04:00	TEA BREAK				
04:00 – 05:00	Gregory Sankaran (AG-66)	Open Problem Session (AG-66)	TEA (4:00 – 4:30)	Mitul Islam (Maths Colloquium) (AG-66)	–
05:00 – 06:00	–	–	Public Lecture Martin Bridson (HBA)	–	–

Geometry and Dynamics

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Abstracts of Talks

**School of Mathematics
Tata Institute of Fundamental Research**

Title of Talks

Radhika Gupta	<i>An invariant for free-by-cyclic groups</i>
Macarena Arenas	<i>The cubical route to understanding Artin groups</i>
Subhojoy Gupta	<i>Entropy and domination for quasi-Hitchin representations</i>
Gregory Sankaran	<i>Blowups with log canonical singularities</i>
Sanju Velani	<i>Shrinking Targets versus Recurrence</i>
Mahesh Kakde	<i>The matrix coefficient conjecture</i>
Jens Marklof	<i>Mathematical models of quantum chaos</i>
Henna Koivusalu	<i>On cut and project sets and substitutions</i>
Subhadip Dey	<i>Fractal Closures of Geodesic Planes in Higher Rank</i>
Martin R Bridson	<i>Automorphism groups of free groups, geometric models, and flavours of rigidity</i>
Mitul Islam	<i>Coarse higher medians and symmetric spaces</i>
Natalia Jurga	<i>Quantitative covering and equidistribution</i>
Mahan Mj	<i>An orbit equivalence framework for combining rational maps and Kleinian groups</i>

Abstracts

Monday, 10 November 2025 (10:00-11:00)

Speaker : Radhika Gupta
Title : An invariant for free-by-cyclic groups

For a free group outer automorphism we define ‘lamination depth’ to be the length of the longest properly nested sequence of its attracting laminations. I will talk about joint work with Spencer Dowdall, Yassine Geurch, Jean Pierre Mutanguha and Caglar Uyanik, where we show that lamination depth is a group invariant of a free-by-cyclic group. That is, a free-by-cyclic group can be viewed as the mapping torus of a free group outer automorphism in multiple ways and we show that each such outer automorphism has the same lamination depth.

Monday, 10 November 2025 (11:30-12:30)

Speaker : Macarena Arenas
Title : The cubical route to understanding Artin groups

Artin groups simultaneously generalise braid groups, free groups, and free abelian groups. They are closely related to Coxeter groups, and like these, can be defined in terms of labelled simplicial graphs. Despite their seemingly straightforward combinatorial nature, hardly anything is known about arbitrary Artin groups, and many outstanding questions remain unanswered for large subclasses of these groups.

In this talk we will explain how to view an Artin group as a quotient of a cubulated group in a way that encodes many aspects of its geometry. We will then explain how this viewpoint – cubical small-cancellation theory – allows us to understand in many cases important properties of the group, such as asphericity and cubulability.

Monday, 10 November 2025 (02:30-03:30)

Speaker : Subhojoy Gupta
Title : Entropy and domination for quasi-Hitchin representations

A famous result of Bowen implies that the entropy or critical exponent of a quasi-Fuchsian representation strictly increases off the Fuchsian locus. I will explain how this follows from a domination result comparing marked length spectra, together with the Anosov property of the geodesic flow. I will then discuss recent

work proving analogues of this in the context of punctured surface-group representations into $\mathrm{PSL}(n, \mathbb{C})$ that are quasi-Hitchin, obtained by bending deformations of positive representations (in the sense of Fock-Goncharov). In the higher-rank case our methods are linear algebraic, and involve weight-matrices of weighted planar networks. This represents joint work, some ongoing, with Pabitra Barman.

Monday, 10 November 2025 (04:00-05:00)

Speaker : Gregory Sankaran
Title : Blowups with log canonical singularities

I will describe a conjecture of Birkar about the singularities of weighted blowups, and the proof (joint work with Paco Santos). Despite its origins in birational geometry, the problem is essentially one in the geometry of numbers, and accessible without substantial prerequisites.

Tuesday, 11 November 2025 (10:00-11:00)

Speaker : Sanju Velani
Title : Shrinking Targets versus Recurrence

Let (X, d) be a compact metric space and $(X, \mathcal{A}, \mu, T)$ be a probability measure preserving system. Furthermore, given a real, positive function $\psi : \mathbb{N} \rightarrow \mathbb{R}_{\geq 0}$ let

$$R(\psi) := \{x \in X : d(T^n x, x) < \psi(n) \text{ for infinitely many } n \in \mathbb{N}\}$$

denote the associated recurrent set, and given a point $x_0 \in X$ let

$$W(\psi) ::= \{x \in X : d(T^n x, x_0) < \psi(n) \text{ for infinitely many } n \in \mathbb{N}\}$$

denote the associated shrinking target set. Under certain mixing properties it is known that if $\sum_{n \in \mathbb{N}} \psi(n)$ diverges then both the recurrent and shrinking target sets are of full μ -measure. The purpose of this talk is to discuss the potential quantitative strengthening of these full measure statements.

This is joint work with Junjie Huang (SCUT), Jason Levesley (York), Bing Li (SCUT), and David Simmons (when at York).

Tuesday, 11 November 2025 (11:30-12:30)

Speaker : Mahesh Kakde
Title : The matrix coefficient conjecture

I will talk about the joint work with Samit Dasgupta where we formulate a conjecture known as the matrix coefficient conjecture. I will talk about its relationship with conjectures in Iwasawa theory and propose a strategy to attack the conjecture.

Tuesday, 11 November 2025 (02:30-03:30)

Speaker : Jens Marklof
Title : Mathematical models of quantum chaos

I will report on recent progress towards fundamental conjectures in quantum chaos, which assert that the statistics of quantum energy levels should be governed by a Poisson point process if the system is completely integrable (Berry & Tabor, 1977) or by random matrix theory if the underlying classical dynamics is “chaotic” (Bohigas, Giannoni & Schmit, 1984). In the case of the Laplacian on flat tori, the question reduces to a natural problem on the distribution of values at integers of a quadratic form, which in turn is intimately related to the classical Oppenheim conjecture. We will also discuss the Laplacian on a compact hyperbolic surface and review some recent evidence for the emergence of random matrix statistics in the limit of high genus.

Wednesday, 12 November 2025 (10:00-11:00)

Speaker : Henna Koivusalu
Title : On cut and project sets and substitutions

Cut and project sets are obtained by taking an irrational slice through a lattice and projecting it to a lower dimensional subspace. This usually results in a set which has no translational period, even though it retains a lot of the regularity of the lattice. As such, cut and project sets are one of the archetypical examples of point sets featuring aperiodic order. The other canonical method for generating aperiodic order is via substitutions; point sets generated from an inflation-redecoration process. Many classical examples of aperiodic order, e.g. the famous Penrose tiling, have a description from both methods. It is hence fundamental to the theory of aperiodically ordered point sets to answer the question:

What property characterises those cut and project sets which have a substitution description?

In this talk I will give an overview of the definition and basic properties of cut and project sets, discuss classical examples of aperiodic order, define the notion of ‘pattern with a substitution rule’, and finally come to a new result of mine, answering the question above. This work is joint with Jamie Walton (Nottingham) and Edmund Harriss (Arkansas).

Wednesday, 12 November 2025 (11:30-12:30)

Speaker : Subhadip Dey

Title : Fractal Closures of Geodesic Planes in Higher Rank

Ratner’s Orbit Closure Theorem states that in finite-volume locally symmetric spaces, closures of immersed totally geodesic submanifolds without flat factors are always smooth. In this talk, I will discuss a recent joint work with Hee Oh demonstrating that such rigidity can fail dramatically in higher-rank locally symmetric spaces of infinite volume. Specifically, we construct Zariski-dense surface groups Γ in $SL(3, R)$ such that in the locally symmetric space $\Gamma \backslash SL(3, R)/SO(3)$, certain immersed hyperbolic 2-planes have fractal closures with non-integer Hausdorff dimension. In fact, such a group Γ can be constructed in $SL(3, Z)$. The construction reveals new geometric and dynamical phenomena in higher rank.

Thursday, 13 November 2025 (02:30-03:30)

Speaker : Martin Bridson

Title : Automorphism groups of free groups, geometric models, and flavours of rigidity

Following a brief review of the powerful 3-way analogy between arithmetic lattices such as $SL(n, Z)$, mapping class groups of surfaces, and automorphism groups of free groups (with emphasis on geometry and dynamics), I shall discuss various types of rigidity for these groups and for the spaces associated to them. I’ll sketch a proof of the fact that, when the rank of F is at least 3, any isomorphism between subgroups of finite index in $Aut(F)$ is the restriction of a conjugation in the ambient group — “Commensurator Rigidity”. I’ll conclude with a discussion of some open problems, including questions about Profinite Rigidity and First-Order Rigidity for these groups. Much of this talk is based on joint work with Mladen Bestvina and Ric Wade.

Thursday, 13 November 2025 (04:00-05:00)

Speaker : Mitul Islam

Title : Coarse higher medians and symmetric spaces

Bowditch introduced the notion of a *coarse median* on a metric space as a simultaneous generalization of metric trees, mapping class groups, and CAT(0) cube complexes. Answering a question of Bowditch, Haettel recently showed that the only higher-rank symmetric spaces that admit a coarse median are products of rank-one spaces, e.g. $\mathbb{H}^2 \times \mathbb{H}^2$. In this talk, we will introduce the notion of a *coarse higher median*, which generalizes Bowditch's medians. We will identify several families of irreducible higher-rank symmetric spaces that admit our generalized median, but not Bowditch's medians. This is joint work in progress with Grazia Rago.

Friday, 14 November 2025 (10:00-11:00)

Speaker : Natalia Jurga

Title : Quantitative covering and equidistribution

One of the fundamental features of an ergodic dynamical system (T, X, m) with $\text{supp}(m) = X$ is that for almost every $x \in X$, the orbit of x is dense in X and the sequence of empirical distributions along its orbit converges to the measure m . In this talk we will discuss quantitative versions of these fact and their connections to the fractal properties of the measure m . This is partially based on work in progress with Mike Todd.

Friday, 14 November 2025 (11:30-12:30)

Speaker : Mahan Mj

Title : An orbit equivalence framework for combining rational maps and Kleinian groups

We discuss a recent orbit equivalence framework for holomorphically mating the dynamics of complex polynomials with that of Kleinian surface groups. We start by demanding a strict orbit equivalence and show that the only torsion-free Fuchsian groups that can be thus mated are punctured sphere groups. We then relax the strict orbit equivalence framework to a virtual orbit equivalence framework allowing us to include certain special orbifolds including the modular surface. Finally, a further relaxation of this framework demanding only orbit equivalence for generic points allows us to expand the scope considerably to all orbifolds of arbitrary genus excluding only compact orbifolds that do not admit an essential simple separating curve, i.e. (p, q, r) orbifolds. Time-permitting we shall mention a closely related framework of algebraic correspondences that arises out of these

matings addressing an old question of Fatou. This is joint work with Yusheng Luo and Sabyasachi Mukherjee.