**International Conference**

**on**

**Algebraic and Analytic Geometry**

**1st to 5th December 2025**

**Venue: C021**

**Invited Speakers and Abstract**

**Speaker: Swarnava Mukhopadhyay**

**Title: Combinatorial Structures in the Moduli of Vector Bundles on Curves**

**Abstract**: In the first part of this talk, we examine cluster-like structures that emerge from the moduli space of rank-two vector bundles on a smooth projective curve with fixed determinant. These structures are constructed by analyzing toric degenerations of the moduli spaces, specifically through the degeneration of the underlying smooth curve to a maximal nodal curve. By performing a change of variables and considering appropriate limits, these cluster-like structures reproduce the Plücker relations for the Grassmannian Gr(2, n). In the second part, we will discuss a combinatorial analog of the Torelli theorem for these limiting toric varieties.

This is a joint work with Pieter Belmans and Sergey Galkin.

**Speaker: Mohan Swaminathan**

**Title** Logarithmic Gromov--Witten theory: algebraic vs symplectic

**Abstract** Logarithmic Gromov--Witten (GW) theory is a deformation-invariant extension of usual GW theory to spaces having mild (e.g., normal crossings) singularities. I will explain two distinct approaches to log GW theory (algebraic and symplectic) and then describe a comparison theorem relating them. This is based on joint work with Mohammad Farajzadeh-Tehrani.

**Speaker: Kashyap Rajeevsarathy**

**Title:** Estimating the Weil-Petersson distance between branch loci

**Abstract:** Let \(\mathrm{Mod}(S_g)\) represent the mapping class group of a closed orientable surface \(S_g\) with genus \(g \geq 2\). For any finite subgroup \(H\) of \(\mathrm{Mod}(S_g)\), we define \(\mathrm{Fix}(H)\) as the set of all fixed points resulting from the action of \(H\) on the Teichmüller space \(\mathrm{Teich}(S_g)\) of \(S_g\). We present a method to estimate the distance between unique fixed points arising from certain irreducible cyclic actions on \(S_g\). Our approach begins with deriving an explicit description of a pants decomposition of \(S_g\) in which the lengths of the curves are bounded above by Bers' constant. We refer to this as an \textit{admissible decomposition}. By combinatorially encoding these admissible decompositions, we establish an upper bound for the distance

between pairs of admissible decompositions within the Pants graph $\mathcal{P}(S_g)$. Subsequently, we utilize the quasi-isometry between $\mathrm{Teich}(S_g)$ and the Pants graph $\mathcal{P}(S_g)$ to obtain this distance estimate. Finally, we discuss how our method can be generalized to estimate the distances between arbitrary branch loci.

**Speaker: Ritwik Mukherjee**

**Title:** Limits of rational cuspidal curves

**Abstract:** We formulate a very precise conjecture about the limiting behaviour of genus zero curves (into P^2) that have a cusp. We conjecture that in the limit, we get a two component rational curve that intersect each other tangentially. Assuming this conjecture, we are able to derive a recursive formula to enumerate rational cuspidal curves in P^2. We go on to make a further conjecture about the limiting behaviour of rational curves with an E6 singularity (in local coordinates, an E6 singularity is given by y^3+x^4 =0). Again, assuming this conjecture we are able to compute the characteristic number of rational quartics in P^2 that have an E6 singularity. Our numerical answers agree with those that have already been obtained by alternative means. This gives solid evidence for our conjectures. Furthermore, the conjectures are geometrically extremely believable. It is likely that a thorough understanding of the standard gluing theorem (that is used in the proof of Kontesevich's recursion formula) and a possible extension of that theorem will enable us to prove these conjectures. This is joint work with Indranil Biswas, Anantadulal Paul and Apratim Choudhury.

**Speaker: Hisashi Kasuya**

**Title:** GIT stability and biquotients of SU(3)

**Abstract:** In the joint work with H. Ishida, we proved that we can construct non-left- invariant complex structures on SU(3) associated with parameters satisfying Japanese fun (Sensu) condition. The purpose of this talk is to give a new interpretation of this construction in terms of GIT. In conclusion, we obtain a family of projective varieties(orbifolds) which are variants of the flag variety expressed as biquotients of SU(3). This talk is based on the joint work with Y. Hashimoto and H. Ishida.

**Speaker: Shoichi Fujimori**

**Title:** Doubly periodic minimal surfaces of genus three with parallel ends

**Abstract:** We construct a one-parameter family of embedded doubly periodic minimal surfaces in Euclidean three space.

Each surface of the family has genus three with four parallel ends in the quotient.

This is joint work with Peter Connor (Indiana University South Bend), Phillip Marmorino (University of Notre Dame), and Toshihiro Shoda (Kansai University).

**Speaker: A J PARAMESWARAN**

**Title:** Relatively Ulrich bundles and the Tannaka category of lf-graded bundles

**Abstract:** Let $f:X \to Y$ be a finite map between smooth projective varieties. A vector bundle $V$ on $X$ is defined to be relatively Ulrich if its pushforward, $f_* V$, is a trivial vector bundle on $Y$. We investigate the properties of these bundles and show that the collection of all relatively Ulrich bundles forms an abelian category. Furthermore, we demonstrate that every relatively Ulrich bundle is semistable with a fixed slope $\mu$, and they are stable under base change. We also show that these bundles are locally free (lf)-graded. This work is motivated by our efforts to construct Tannaka categories of graded vector bundles. In earlier work with Indranil Biswas, we constructed a Tannaka category of $\mathbb{Q}$-graded vector bundles over smooth projective curves, where each factor consisted of semistable bundles. Subsequently, in joint work with Balaji, we generalized this construction to higher dimensions by requiring the factors in the category to be lf-graded, a property naturally satisfied by the relatively Ulrich bundles studied here. This is a joint work with Indranil Biswas and Manish Kumar.

**Speaker: Jeongseok Oh**

**Title:** A pullback between sheaves on log Calabi-Yau 4-folds

**Abstract:** Given a section of a bundle with quadratic form, we construct a specialisation map between K-groups of matrix factorisations of the quadratic function from the space to the normal cone of the zero locus. When the section is isotropic, the quadratic function becomes zero and the construction recovers usual specialisation map in Fulton-MacPherson's intersection theory. When a log Calabi-Yau 4-fold (X,D) is given, we apply the construction to define a pullback from sheaves on D to ones on X after assuming the space of sheaves on D is a critical locus globally. For a Calabi-Yau 4-fold X, we artificially define "the space of sheaves on D" to be a point so that its structure sheaf pulls back to the virtual structure sheaf of the space of sheaves on X.

This is a joint work in progress with Dongwook Choa and Richard Thomas.

**Speaker: Krishna Hanumanthu**

**Title:** SHGH Conjecture

**Abstract:** A classical polynomial interpolation problem asks: given a set of points in the Euclidean plane and a positive integer d, is there a real polynomial of degree d in two variables which vanishes at the given points? This problem has a rich history and many variants. The variant of interest for us concerns linear system of complex plane curves of a fixed degree with prescribed multiplicities at a given set of very general points in the complex projective plane. In this direction, Segre (1961), Harbourne (1985), Gimigliano (1987) and Hirschowitz (1989) independently formulated a conjecture (known as the SHGH Conjecture) which asserts that this linear system has the expected dimension except in certain explicitly described exceptional cases. Although some cases are known, this conjecture is open in general. A lot of interesting work is being done around this conjecture and it has some important and surprising consequences. In this talk, we will introduce the SHGH conjecture, discuss some known cases and mention a few consequences.

**Speaker: Anoop Singh**

**Title:** Tannakian category of holomorphic Lie algebroid connections over a curve

**Abstract**: Let $(V, \phi)$ be a holomorphic Lie algebroid over a compact connected Riemann surface X. We consider the category of integrable holomorphic $(V, \phi)$–connections on X, and also a full subcategory of it consisting of those integrable $(V, \phi)$–connections for which the underlying vector bundle is holomorphically trivial. It is shown that these

two are neutral Tannakian categories provided the anchor map $\phi$ is surjective. We study the characters of corresponding affine group schemes. We also established an equivalence between certain tensor categories associated with Lie algebroid connections.

This is a joint work with Indranil Biswas and A. J. Parameswaran

**Speaker: Norbert Hoffmann**

**Title:** Degeneration and descent for universal principal bundles over del Pezzo surfaces

**Abstract:** Let S be a split del Pezzo surface over a field k, let T be the torus over k that is dual to Pic( S), and let G be the reductive group over k with maximal torus T and the same root system as S. The universal principal T-bundle over S of Colliot-Thelene and Sansuc does not always descend to nonsplit del Pezzo surfaces, and it does not degenerate naturally to singular del Pezzo surfaces. The talk will discuss to which extent this improves if the T-bundle is replaced by its extension of structure group to G, as motivated by a construction of Friedman and Morgan for individual singular del Pezzo surfaces. This is joint work with Ulrich Derenthal.