Title and Abstract

July 18, Monday

(1) **Nitin Nitsure (TIFR Mumbai)**

Title: On Harder-Narasimhan stratifications

Abstract: In the mid 1970s, G. Harder and M.S. Narasimhan [1975] quantified the instability of a vector bundle on a curve via their invention of Harder-Narasimhan types (HN-types), together with a natural partial order on the set of HN-types. Soon after that, S.S. Shatz [1977] defined HN-types for vector bundles (or torsion free coherent sheaves) on any projective variety, and he proved that the HN-types define a set-topological stratification (the HN-stratification) of the parameter scheme of any family of vector bundles (or torsion free coherent sheaves)

on the variety. After three decades, the speaker [2011] showed that there is in fact a scheme-theoretic HN-stratification on the parameter schemes of any family of pure coherent sheaves on a projective scheme over an arbitrary base, giving rise to algebraic stacks with suitable universal properties. In collaboration with S. Gurjar, these results were extended to lambda modules in the sense of Simpson on a projective scheme over an arbitrary base, and to principal bundles in characteristic zero on a smooth projective variety with reductive structure groups in dimension one [2014] and in higher dimensions [2017]. After briefly reviewing the above results, I will give an exposition of my joint work (preprint) with Gurjar, on HN-stacks for principal bundles in higher dimensions and arbitrary characteristics.

(2) **Jaya N Iyer (IMSc)**

Title: Regulators of canonical extensions

Abstract: We will discuss some constructions and questions arising from Chern Simons theory. We will end by indicating the triviality of Volume regulators of canonical extensions on smooth projectove varieties. This is joint work with C. Simpson.

(3) **Sudarshan Gurjar (IIT Bombay):**

Title: Zariski finiteness theorem and some properties of ring of invariants

Abstract: The main aim of the talk is to discuss two theorems which belong to the interface of commutative algebra, algebraic geometry and invariant theory: The first is a new proof of a special case of the Zariski finiteness theorem, namely : Let T be an affine factorial domain $\mathbb{C}$. Let S be an inert subring of T such that the transcendental degree of S over $\mathbb{C}$ is 2. Then S is finitely generated algebra over $\mathbb{C}$.

The other is a criterion for the quotient $\mathbb{A}^3_C//G_a$, to be a Zariski locally trivial $\mathbb{A}^2$-bundle over C, where C is a smooth complex curve. More precisely we show that if R is a regular complex affine domain of dimension 1 and suppose the additive group G_a acts by R-automorphisms on $R[X, Y, Z]$ such that the singular fibers of the quotient map Spec $R[X, Y, Z]$ to Spec $R[X, Y, Z]^{G_a}$ are normal, then this quotient map is a locally trivial $\mathbb{A}^2$-bundle.

The novelty feature in both proof is the use of standard algebraic topology. All these results are obtained in joint work with R.V. Gurjar and B. Hajra and published in Transformation Groups journal.

Link: `https://link.springer.com/article/10.1007/s00031-020-09594-0`

(4) **Inder Kaur (Goethe University Frankfurt, Germany):**

Title: A cohomological version of the singular Hodge conjecture

Abstract: The classical Hodge conjecture for smooth, projective varieties has been open for over 70 years, although it has only been proven for some specific varieties. In this talk I will discuss a cohomological version of the Hodge conjecture for singular varieties and give a sufficient condition for a singular variety to satisfy it. As a consequence we also obtain several new examples of varieties that satisfy the classical Hodge conjecture. This is joint work with Ananyo Dan.

(5) **Ananyo Dan (University of Sheffield):**

Title: Topological and geometric obstruction to deformation of divisors

Abstract: Given a smooth, projective variety X and a local complete intersection subscheme Z in X, Blochs semi-regularity map relates the obstruction to the geometric deformation of Z (i.e., the deformation of Z as a l.c.i. subvariety) to the obstruction to the topological deformation of Z (i.e., the deformation of the cohomology class of Z). The question we will discuss in this talk is when the two obstruction theories are equivalent. The notion of classical semi-regularity is too strong in the sense that there are examples of divisors where the two obstruction theories are equivalent, although the variety is not semi-regular. In this talk we discuss a weaker version of semi-regularity, which we will call T-semi-regularity for closed subvarieties T of divisors. For correct choices of T, a divisor is T-semi-regular if and only if the two obstruction theories are equivalent. We also compare it with the classical semi-regularity. This is joint work with I. Biswas.

July 19, Tuesday

(1) **Sujoy Chakraborty (IIT Madras)**

Title: Brauer group of the moduli stack of stable parabolic $PGL(r)$– bundles over a curve

Abstract: Let k be an algebraically closed field of characteristic zero. We prove that the Brauer group of moduli stack of stable parabolic $PGL(r,k)$– bundles with full flag quasi-parabolic structures at an arbitrary parabolic divisor on a curve X coincides with the Brauer group of the smooth locus of the corresponding coarse moduli space of parabolic $PGL(r,k)$– bundles. We shall also get a description of the Brauer group of the smooth locus of this coarse moduli for more general quasi-parabolic types and weights satisfying certain conditions.

(2) **Mitra Koley (ISI KOlkata)**

Title: Gröbner deformations and F- singularities

Abstract: For a commutative ring R of prime characteristic p, the map $F : R \to R$ sending $r \mapsto r^p$ is a ring endomorphism, called the Frobenius morphism. Frobenius morphism plays an important role in studying singularities of such rings. The singularities that have been defined in terms of the Frobenius map are called F-singularities. In this talk we will look at the question how F-singularities behave along Gröbner deformation. This approach gives us a way to study F-singularities of various combinatorial algebras. For example, we will see that the algebras defined by binomial edge ideals are always F-injective (one class of F-singularity). This is a joint work with Matteo Varbaro.

(3) **Mandira Mondal (CMI)**:

Title: Density function for the second coefficient of the Hilbert-Kunz function

Abstract: For a Noetherian local ring R of characteristic $p > 0$, an ideal I of R of finite colength and a finitely generated R-module M, the Hilbert-Kunz multiplicity of M with respect to I, $e_{HK}(M, I)$, is an important invariant which measures the asymptotic growth of certain length functions, called the Hilbert-Kunz function. In addition, if R is a standard graded ring over a perfect field of characteristic $p > 0$, I is a graded ideal and M is a graded R-module, the Hilbert-Kunz density function of M with respect to I is a compactly supported continuous function $f_{M,I} : [0, \infty) \longrightarrow [0, \infty)$, whose integration yields $e_{HK}(M, I)$. In this talk we give a brief introduction to the theory of Hilbert-Kunz multiplicity and Hilbert-Kunz density function. We shall later discuss the existence of a density function for the second coefficient of the Hilbert-Kunz length function. We shall assert the existence of such a density function on the

class group of projective toric varieties. This talk will be (partially) based on joint work with Prof. V. Trivedi.

(4) **Tomas Gomez (ICMAT, Spain)**

Title: The derived category of the moduli space of vector bundles on a curve

Abstract: Let $M(2, L)$ be the moduli space of vector bundles on a curve C, of rank 2 and fixed determinant L of odd degree. Narasimhan and Belmans-Galkin-Mukhopadhyay have independently conjectured that its derived category admits a semiorthogonal decomposition

$$D(M(2, L)) = \langle D(pt), D(pt), D(C), D(C), D(C_2), D(C_2) \cdots, D(C_{g-2}), D(C_{g-2}), D(C_{g-1})\rangle.$$

where C_i is the i-th symmetric product of the curve C and $pt = C_0$ is a point. I will present recent work by several mathematicians on this conjecture and generalizations, including joint work with Indranil Biswas and Kyoung-Seog Lee.

(5) **Suhas B N (St. Joseph's College of Bangalore)**

Title: The stability of kernel bundles over chain-like curves

Abstract. Let $n \geqslant 2$ be a positive integer. Let C be reduced projective curve over $\mathbb{C}$ having n smooth irreducible components C_i of genus g_i and $n-1$ nodes p_i such that $C_i \cap C_j = \emptyset$, whenever $|i-j| > 1$ and $C_i \cap C_{i+1} = \{p_i\}$, for $i = 1, \ldots, n-1$. Such a curve C is called a *chain-like curve*. Suppose $\mathcal{V}$ is a nonzero finite dimensional vector space over $\mathbb{C}$ and $\mathcal{M}$ is a subbundle of the trivial bundle $\mathcal{V} \otimes \mathcal{O}_C$ over a chain-like curve C such that $\mathrm{rk}(\mathcal{M}) = m$, $\chi(\mathcal{M}) < 0$, and the quotient $\mathcal{E} := \frac{\mathcal{V}\otimes\mathcal{O}_C}{\mathcal{M}}$ is locally free. Suppose also that $\mathcal{M}_{|C_j}$ is semistable for each j. Then we prove that there exists a polarization w such that $\mathcal{M}$ is w-semistable. Further, we also prove that if $\mathcal{M}_{|C_j}$ is stable for some j, then $\mathcal{M}$ is w-stable. Now, suppose E be a vector bundle of rank r on C and V is a linear subspace of $H^0(E)$ with $\dim V = k > r$ such that V generates E.

We define the *kernel bundle* $M_{E,V}$ of the generated pair (E, V) to be the kernel of evaluation map $V \otimes \mathcal{O}_C \to E$. Let (E, V) be a generated pair on C. As a corollary of the above result, we also prove that if for each j, $M_{E,V_{|C_j}}$ is semistable, then there exists a polarization w such that $M_{E,V}$ is w-semistable. Further, we provide some sufficient conditions under which $M_{E,V} \otimes L$ becomes strongly unstable, for any line bundle L on C. This presentation is based on joint work with Susobhan Mazumdar and Amit Kumar Singh.

July 20, Wednesday

(1) **V Suresh (Emory University, USA)**

Title: Local-global principle for quadratic forms and projective homogeneous spaces

Abstract: Let q be a homogeneous polynomial of degree 2 (known as quadratic form) with integer coefficients. A theorem of Minkowski asserts that q has a nontrivial zero over integers if and only it has a nontrivial zero over the field of real numbers and has a nontrivial zero modulo p^n for all prime numbers p and integers $n \geqslant 1$. A theorem of Hasse-Minkowski asserts that a quadratic form q over a number field K has a nontrivial zero over K if and only if it has a nontrivial zero over the completion K_υ of K at all places υ of K. More generally a theorem of Harder asserts that if G is a connected linear algebraic group defined over a number field K and X is a projective homogeneous space under G over K, then $X(K) \neq \emptyset$ if and only if $X(K_\upsilon) \neq \emptyset$ for all places υ of K.

Let K be a p-adic field and F the function field of a curve over K. Let q be a quadratic form over F of dimension at least 3. Then we show that q has a nontrivial zero over F if and only if it has a nontrivial zero over the completion F_υ of K at all discrete valuations υ of K. We also prove that if G is a connected linear algebraic group of classical type defined over F and X is a projective homogeneous space under G over F, then $X(F) \neq \emptyset$ if and only if $X(F_\upsilon)$ for all discrete valuations υ of F.

(2) **Manish Kumar (ISI Bangalore)**

Title: On the embedding problems for fundamental groups

Abstract: The étale fundamental group of a smooth curve over a field of positive characteristic is a quite mysterious. One way to understand this group is to understand the inverse system of the finite groups which define the fundamental group. Embedding problems help in understanding this inverse system. Translated in terms of étale covers, it tells us how various Galois étale covers fit together. I will talk about certain necessary and certain sufficient conditions for an embedding problem (or its restriction to subgroups) of the fundamental group to have a solution.

(3) **Krishna Hanumanthu (CMI)**

Title: Seshadri constants

Abstract: Seshadri constants arose out of an ampleness criterion due to C. S. Seshadri. They were defined by J-P. Demailly in 1990 in order to study generation of jets by line bundles. These constants have emerged as an important topic in the study of positivity in algebraic geometry. We will talk about some well-known results and

questions on Seshadri constants and discuss some recent results.

(4) **Md. Ali Zinna (IISER Kolkata)**

Title: Efficient generation of ideals

Abstract: Let R be a Noetherian ring. An ideal I of R is called efficiently generated if $\mu(I) = \mu(I/I^2)$, where $\mu(I)$ denotes the minimal number of generators of I (as an R-module). In this talk we will provide sufficient conditions for an ideal I to be efficiently generated.

(5) **Chandranandan Gangopadhyay (IIT Bombay)**
Title: Infinitesimal deformations of some Quot Schemes

Abstract: Let E be a vector bundle on a smooth complex projective curve C of genus at least two. Fix an integer $d > 1$. Let Q be the Quot scheme that parametrizes the torsion quotients of E of degree d. In this talk we will compute the sheaf cohomology of the tangent bundle of Q. In particular, we will study the space of first order infinitesimal deformations of Q. This is a joint work with Indranil Biswas and Ronnie Sebastian.

(6) **Jyoti Dasgupta (IISER Pune)**

Title: Seshadri constants of equivariant vector bundles on toric varieties

Abstract: Seshadri constants measure the local positivity of an ample line bundle. They were introduced by Demailly. Later, Hacon generalized the notion of Seshadri constants to vector bundles. In this talk, we consider torus equivariant vector bundles on toric varieties. Assuming certain conditions on the vector bundle, we compute precise values of Seshadri constants at arbitrary points on projective spaces and Bott towers of height at most 3. This talk is based on joint work with Bivas Khan and Aditya Subramaniam.

July 21, Thursday

(1) **Jugal K Verma (IIT Bombay):**

Title: On the Hilbert-Samuel polynomial of Frobenius powers of ideals and a question of I. Smirnov

Abstract: We provide suitable conditions under which the asymptotic limit of the Hilbert-Samuel coefficients of the Frobenius powers of an m-primary ideal exists in a Noetherian local ring with prime characteristic This, in turn, gives an expression of the Hilbert-Kunz multiplicity of powers of the ideal. We also prove that for a face ring of a simplicial complex and an ideal generated by pure powers of the variables, the generalized Hilbert-Kunz function is a polynomial f and also obtain a formula for the Hilbert-Kunz multiplicity of powers of certain ideals. A counter-example to a conjecture proposed by I. Smirnov that connects the stability of an ideal with the asymptotic limit of the first Hilbert coefficient of the Frobenius power of the ideal.

This is joint work with Arindam Banerjee (IIT Kharagpur) and Kriti Goel (University of Utah).

(2) **Mrinal Kanti Das (ISI Kolkata)**

Title: Monic inversion principle

Abstract: Let R be a commutative Noetherian ring and P be a statement on objects defined over $R[T]$. We say that the monic inversion principle holds for P if the validity of P_f implies the validity of P, where f is a monic polynomial. Starting from the classical results on this theme we shall give an overview of various problems. Some of the problems are tantalizingly open, even now. Some recent results will be presented which do not require much of a prerequisite.

(3) **Indranath Sengupta (IIT Gandhinagar)**

Title: Projective Closure of Numerical Semigroups and Affine Monomial curves

Abstract: A Numerical Semigroup Ring is the coordinate ring of an affine monomial curve, which is always Cohen-Macaulay. However, under projective closure, most of the good properties are not preserved any more. In this talk, we will discuss some such questions and present some results answering such questions. This talk is based on ongoing work with Pranjal Srivastava, Joydip Saha, Om Prakash Bhradwaj and Kriti Goel.

(4) **Manoj Kummini (CMI)**

Title: Polynomial invariant rings in modular invariant theory.

Abstract: Let G be a finite group acting linearly on a finite-dimensional vector-space V over a field K. Let R denote the symmetric algebra on V^*; then G acts as graded K-algebra automorphisms on R. If R^G is a polynomial ring, then G is generated by elements that act as pseudo-reflections on V. The converse holds when $|G|$ is invertible in K. The above results are Shephard-Todd-Chevalley-Serre theorem. If $\mathrm{char}(K) = p > 0$ and G is a p-group, then a conjecture of Shank-Wehlau-Broer asserts that R^G is a polynomial ring if R^G is a direct summand of R as an R^G-module. We verify this conjecture in dimension three and prove some results supporting the conjecture in dimension four. This is joint work with Mandira Mondal.

(5) **Oscar Garcia-Prada (ICMAT, Spain)**

Title: Higgs bundles and higher Teichmller spaces

Abstract: It is well-known that the Teichmüller space of a compact real surface can be identified with a connected component of the moduli space of representations of the fundamental group of the surface in $PSL(2, R)$. Higher Teichmüller spaces are generalizations of this, where $PSL(2, R)$ is replaced by certain simple non-compact real Lie groups of higher rank. As for the usual Teichmüller space, these spaces consist entirely of discrete and faithful representations. Several cases have been identified over the years. First, the Hitchin components for split groups, then the maximal Toledo invariant components for Hermitian groups, and more recently certain components for $SO(p, q)$. In this talk, I will describe a general construction of all possible higher Teichmüller spaces, and a parametrization of them using the theory of Higgs bundles, given in joint work with Bradlow, Collier, Gothen and Oliveira.

(6) **Dilip Patil (IISc, Bangalore):**

Title: Trace Forms and Rational Points

Abstract: In this talk we use trace form and its generalizations to give a criterion for the existence of rational points of a finite algebra over a real closed field.

July 22, Friday

(1) **A. J. Parameswaran (TIFR Mumbai)**

Title: Genuinely ramified maps

Abstract: Will be a survey on the topic. Will give various equivalent definitions and then state many results that are proved jointly with Subramanian, Balaji, Indranil, Soumyadeep and Manish Kumar.

(2) **Mainak Poddar (IISER Pune)**

Title: Equivariant splitting of toric principal bundles over projective spaces.

Abstract: I will describe a classification of torus equivariant principal G-bundles over a complex nonsingular toric variety where G is a complex linear algebraic group. I will discuss a connection between their equivariant automorphisms and equivariant reduction of structure group. Using this we will show the existence of a torus equivariant splitting of such a bundle over the projective space of dimension n when G is a reductive subgroup of $GL(r)$ for $r < n$. This generalizes a theorem of Kaneyama on the existence of equivariant splitting of any torus equivariant vector bundle of rank $r < n$ over a projective space of dimension n. The talk is based on joint works with Indranil Biswas, Jyoti Dasgupta, Arijit Dey and Bivas Khan.

(3) **Vikraman Balaji (CMI Chennai)**

Title: Bruhat-Tits group schemes on higher dimensional rings

Abstract: Classically Bruhat-Tits theory studies reductive groups over discrete valuation rings and in particular studies a class of "bounded" groups which are realizable as valued points of smooth group schemes over the ring. These constructions have not been generalized to more general regular local rings. These come up naturally in questions related to the problem of degeneration of moduli stacks of torsors and also some questions related to the geometry of Shimura varieties. The aim of the talk is to give an overview of some recent work of mine with Yashonidhi Pandey on the construction of Bruhat-Tits group schemes on the higher dimensional bases.

(4) **Sarbeswar Pal (IISER Trivandrum)**

Title: Existence of Ulrich Bundle on some surfaces of general type

Abstract: Let X be a smooth projective algebraic surface of Picard rank one with very ample canonical bundle K_X. We further assume that $q + 1 \leqslant \chi(\mathcal{O}_X)$, where $q = h^1(\mathcal{O}_X)$. In this talk, we will prove the existence of rank 2 Ulrich bundle and its

stability property of it with respect to K_X. This is a joint work with Dr. Suratno.

(5) **Yagnaseni Dutta (University of Bonn)**

Title: Curves on K3 surfaces and a conjecture of Matsushita

Abstract: I will report on a recent joint work with D. Huybrechts where we strudied how wildly the complex structures of smooth (general) curves on a given K3 surface can vary when they deform inside the surface. We prove that if the curve lies in a large enough ($>= 3$) multiple of an ample and base point free linear system then the complex structures of general curves on that linear system vary maximally. In the genus 2 case we can say more. The original motivation for this problem comes from a conjecture of Matsushita about variation of complex structures of general fibers of Lagrangian fibrations of hyperkaehler manifolds. I will briefly discuss the current state of affairs on this conjecture.

July 23, Saturday

(1) **Arijit Dey (IIT Madras)**

Title: Stabilty of equivariant bundles on toric variety.

Abstract: Let X be a smooth complex projective toric variety under the action Of torus T. In this talk I will discuss some results related to stability of T- equivariant vector bundles as well as principal G bundles on X.

(2) **Akash Sengupta (Columbia University):**

Title: A radical Sylvester-Gallai theorem for cubics

Abstract: The classical Sylvester-Gallai (SG) theorem in discrete geometry shows that if a finite set of points in $P \subset \mathbb{R}^n$ has the property that every line through any two of its points intersects the set P at a third point, then all the points in P must lie on a line, in particular the linear span of the set P is one dimensional. Subsequently several linear and non-linear generalizations of Sylvester-Gallai theorem have been proposed, which are known as Sylvester-Gallai type problems. These problems have interesting connections to Algebraic geometry and have found applications in algebraic complexity theory (in Polynomial Identity Testing - PIT) and coding theory (Locally Correctable Codes). The underlying theme in these questions is:

Are Sylvester-Gallai type configurations always low-dimensional?

In this talk, I'll discuss a Sylvester-Gallai type problem for polynomials. I'll approach the problem from an algebraic geometry and commutative algebraic point of view and show that a radical Sylvester-Gallai configuration of cubic polynomials must have small dimension. This talk is based on joint work with Rafael Oliviera.

(3) **Snehajit Misra (CMI)**

Title: Seshadri Constants for parabolic ample bundles

Abstract: The Seshadri constants for ample line bundles were introduced by Demailly to tackle Fujita Conjecture. Subsequently, these interesting invariant are defined by Hacon in case of ample vector bundles extending Demailly's definition. In this talk, we will introduce the notion of parabolic Seshadri constants for parabolic ample vector bundles and will discuss some of its properties. This talk will be based on a joint work with Indranil Biswas, Krishna Hanumanthu and Nabanita Ray.

(4) **Arjun Paul (IISER Kolkata):**

Title: Logarithmic connection on bundles

Abstract: We discuss the notion of logarithmic connection on vector bundles and principal bundles defined on a smooth complex projective variety, and criterions for existence of a logarithmic connection on bundles singular along a divisor.

(5) **Sourav Das (University of Haifa)**

Title: Higgs bundles on nodal curves

Abstract: In I987 Nigel Hitchin proved that the moduli space of Higgs bundles on a smooth projective curve (of genus greater than equal to 2) has a natural symplectic structure. In this talk I will briefly recall a few features of the moduli space. Then I will discuss the moduli spaces of Higgs bundles on nodal curves and how they are related to the moduli spaces of Higgs bundles on smooth curves via nice degenerations. I will also show that there is a relative log-symplectic structure on such a degeneration.