Titles and abstracts

Plenary talks

A. Lior Yanovski (Hebrew University, Levitzki Prize Recipient) – Higher representation theory

Abstract: In homotopy theory, spaces have a "linear" analog known as *spectra*, which are like topological abelian groups but with all the axioms relaxed to hold only up to (coherent) homotopy. These objects are ubiquitous in mathematics from cobordism spectra in geometry to algebraic K-theory spectra in number theory. Their study is part of the rapidly evolving field of *higher algebra*. A remarkable aspect of the theory is the appearance of new "field characteristics'' interpolating between characteristic 0 and characteristic p. In this intermediate range, an array of deep phenomena emerges. Among them is the notion of *higher semiadditivity* introduced by Hopkins and Lurie, which extends finite summation to integration along certain ''homotopically finite spaces''. This allows one to develop the representation theory in these intermediate characteristics for certain higher homotopical generalizations of finite groups. In this talk, I will outline some aspects of this theory and its applications. This will include various joint works with Barthel, Ben-Moshe, Carmeli, and Schlank.

B. Ohad Klein (Mobileye, Nessyahu Prize Recipient) – Slicing all edges of an n-cube requires at least $n^{2/3}$ hyperplanes

Abstract: Consider the n-cube graph in R^n, with vertices $\{0,1\}^n$ and edges connecting vertices with Hamming distance 1. How many hyperplanes are required in order to dissect all edges? This problem has been open since the 70s. We will discuss this and related problems.

Puzzle: Show that n hyperplanes are sufficient, while $\sqrt{n}$ are not enough.

Student talks

1. Michal Amir (Technion) – New simple lattices in products of Davis complexes

Abstract: Burger & Mozes constructed simple groups which act geometrically on products of regular trees. In this talk I will present new examples of simple groups which act geometrically on products of a regular tree and a two-dimensional Davis complex.

Joint work with Nir Lazarovich.

2. Ohad Avnery (Tel Aviv University) – Irreducible Polynomials Over Number Fields

Abstract: Given a random polynomial with integer coefficients $f(x) \in Z[X]$, do we expect it to be irreducible? This problem has been studied extensively over the last few decades. Recently, Bary-Soroker, Koukoulopoulos and Kozma showed that if we uniformly sample the coefficients of f from an interval $I \subset Z$ of size ≥ 35, then as the degree $n = \deg(f)$ tends to infinity, f is irreducible with probability tending to 1.

Our results generalize this work for fields other than Q. For example, let $A = \{a + bi: 1 \leq a, b \leq 10\}$ in $Q(i)$. Then as f's coefficients are uniformly sampled from A, f is irreducible over $Q(i)[X]$ with probability tending to 1. In this talk we will discuss these results, their generalization to all number fields K/Q, and some key components in the proof.

3. Peleg Bar-Lev (Tel Aviv University) – On two cohomologies in symplectic topology and their relative structure

Abstract: Pseudo-holomorphic curves are a widely used tool in symplectic topology, introduced to the field by Gromov in 1985. One of the ways to use them is to deform the "classical" cohomology ring of a manifold, particularly in two natural situations: that of the symplectic manifold itself, and that of a nice type of submanifold called Lagrangian.

In this talk, I will present these deformed cohomologies and describe two module structures on that of a Lagrangian submanifold over that of the ambient symplectic manifold. While these structures seem different on chain level, we will see that they coincide in cohomology.

4. Guy Blachar (Bar-Ilan University) – Rank-stability of polynomial equations

Abstract: If two matrices almost commute, are they close to a pair of commuting matrices? This is one example of Ulam's stability problem, asking if every 'almost' solution of an equation (i.e. an approximate solution with respect to some metric) is 'close' to an exact solution. Extending the thoroughly studied theory of group stability, we study Ulam stability type problems for associative and Lie algebras. Namely, we investigate obstacles to rank-approximation of matrix 'almost' solutions by exact solutions for systems of non-commutative polynomial equations.

This leads to a rich theory of stable associative and Lie algebras, with connections to linear soficity, amenability, growth, and group stability. We develop rank-stability and instability criteria, examine the effect of algebraic constructions on rank-stability, and prove that while finite-dimensional associative algebras are rank-stable, 'most' finite-dimensional Lie algebras are not.

Joint work with Tomer Bauer and Be'eri Greenfeld.

5. Omer Cantor (University of Haifa) – Generators of the special linear Lie algebras

Abstract: The number of generators of a group or algebra is a rough measure of its complexity. After listing a few examples, I will mention existing results by Jean-Marie Bois and Alisa Chistopolskaya about the number of generators of the special linear Lie algebras over an infinite field of characteristic $\neq 2$. I will then explain the results and proof outline of my recent paper with Urban Jezernik and Andoni Zozaya, in which we find the number of generators of the special linear Lie algebras over an arbitrary field.

The special linear Lie algebras are simple. Typically, the number of generators of a simple group or algebra is 2, but in our case, there are two exceptions to that, and one of them indicates a possible connection to a conjecture of Hans Zassenhaus.

This talk is intended to be accessible to mathematicians without background in algebra.

6. Nuha Diab (Tel Aviv University) - Spectral Properties of Infinitely Smooth Kernel Matrices in the Single Cluster Limit, with Applications to Multivariate Super-resolution

Abstract: In this work, we study the spectral properties of infinitely smooth multivariate kernel matrices when the nodes form a single cluster. We show that the geometry of the nodes plays an important role in the scaling of the eigenvalues of these kernel matrices. For the multivariate Dirichlet kernel matrix, we establish a criterion for the sampling set ensuring precise scaling of eigenvalues. Additionally, we identify specific sampling sets that satisfy this criterion. Finally, we discuss the implications of these results for the problem of super-resolution, i.e. stable recovery of sparse measures from bandlimited Fourier measurements.

Joint work with Dmitry Batenkov.

7. Adi Dickstein (Tel Aviv University) – Symplectic embeddings and quasi-states

Abstract: The cornerstone of symplectic topology is Gromov's remarkable non-squeezing theorem, which says that a symplectic ball cannot be symplectically embedded into a thin cylinder, even though there are no volume obstructions to such an embedding. On the other hand, a result due to Schlenk says an arbitrarily large portion of the volume of any symplectic manifold can be covered by a symplectically embedded standard set, if it is thin enough. We generalize this last result to any probability measure on the symplectic manifold. From this we derive a constraint on the possible constructions of symplectic quasi-states, which are objects of prominence in symplectic geometry introduced by Entov and Polterovich.

Joint work with Frol Zapolsky.

8. Alon Feldman (Technion) – Computer vision for air quality

Abstract: This research introduces computer vision and machine learning techniques to improve air pollution monitoring in urban areas. Traditional air quality monitoring, limited by sparse sensor networks, often fails to capture the fine-scale spatial variations in pollution. The first approach involves using dashboard cameras as low-cost sensors to estimate air quality by training a Convolutional Neural Network on visual data from a mobile sensing campaign in Bangalore, India. The second approach develops dense pollution maps from sparse measurements using air pollution simulators and machine learning interpolation. By modeling environments and employing methods like linear regression, the study demonstrates that even with noisy data, multiple low-cost sensors can effectively map pollution. These methods provide scalable, cost-effective solutions for detailed air quality assessment, aiding in better urban planning and public health interventions. This work showcases the potential of AI-driven techniques to enhance environmental monitoring and decision-making.

9. Ben Feuerstein (Tel Aviv University) – Dichotomy of Hofer Growth Type on the 2-Sphere

Abstract: Given a symplectic manifold (M, ω), the set of its Hamiltonian diffeomorphisms, $Ham(M, \omega)$, forms a group with respect to composition. One can define a metric on this group called Hofer's metric, denoted d_H. This metric space is the subject of much active research and will be the main topic of the talk.

A question we will focus on is the following: given $\phi \in Ham(M, \omega)$, generated by an autonomous Hamiltonian, how does $d_H(\phi^n, 1)$ behave as n approaches infinity? All known examples follow a dichotomy: this distance either remains bounded or grows linearly. It is conjectured that this dichotomy always holds.

In our work, we provide a positive answer to this conjecture in the case of the 2-sphere, along with a slightly stronger result, which we call "enhanced dichotomy". Our approach involves a new technique, Hamiltonian symmetrization.

In this talk, I will give a brief introduction to $Ham(M, \omega)$ and d_H, and discuss symmetrization and our proof.

Joint work with Leonid Polterovich, Lev Buhovsky, and Egor Shelukhin.

10. Rei Henigman (Tel Aviv University) – Classification of symplectic non-Hamiltonian circle actions on 4-manifolds

Abstract: In 1999, Karshon gave a full classification of Hamiltonian circle actions on compact connected symplectic 4-manifolds up to equivariant symplectomorphisms. This talk extends this classification to the non-Hamiltonian case. We describe a set of invariants for symplectic non-Hamiltonian circle actions on compact connected symplectic 4-manifolds, under an integrability assumption. Our main result is that this set of invariants completely classifies the actions up to equivariant symplectomorphisms. In contrast to the Hamiltonian case, we discover multiple topological phenomena that previously only appeared in higher-dimensional Hamiltonian actions. We will provide explicit examples and describe how to calculate the invariants for these examples.

11. Matthias Hippold (Hebrew University) – The Moduli Space of Cyclic Covers of the Projective Line in Positive Characteristic

Abstract: Smooth projective curves C of genus g that admit an action of a finite cyclic group G such that $C/G = P^1$ constitute a moduli space ASW_g that is an interesting sublocus of the moduli space of smooth curves. This subspace is well understood when the characteristic of the ground field does not divide the cardinality of G but in the general case there are many open questions.

We will study Z/p^n-covers in characteristic $p > 0$ and at first introduce the notion of conductors ι of such covers that split ASW_g into different components $ASW_{g,\iota}$. Then, we will describe how the irreducible components of $ASW_{g,\iota}$ can be enumerated by integer matrices satisfying some conditions. Finally, we will explain how these new invariants can be used to determine in some cases for which data (g,ι) the moduli space $ASW_{g,\iota}$ is irreducible or connected and illustrate these criteria in some examples.

This talk is based on joint work of Huy Dang and the speaker.

12. Tal Kagalovsky (Ben Gurion University) – Generalizing Miller's proof to split a family of sets in ZFC

Abstract: In 1937, Miller demonstrated that given a family of sets, all of which are of the same infinite cardinality and assuming that the family satisfies a certain strict disjointedness condition, there exists a set, which intersects all the sets in the family but is not contained in any of them. We call the existence of such a set "property B". In 1961, Erdős and Hajnal showed that for large enough sets (and assuming GCH), it is possible to weaken the disjointedness condition of the family and for it to still satisfy property B. Later, in 2013, Kojman demonstrated that, without assuming GCH, a weakened (yet still very strict) version of the disjointedness condition exists, such that the family still satisfies property B.

In my talk, I will explain the techniques used by Miller in his original, rather simple proof, and show how it can be generalized in order to be applicable to the theorems proved by Erdős-Hajnal, and Kojman.

13. Markos Karameris (Technion) – Whittaker functions for Steinberg representations of $GL(n)$ over a p-adic field

Abstract: Let $G = GL_n(F)$ and let (π_{St}, V) be a (generalized) Steinberg representation of G. It is well known that the space of Iwahori fixed vectors in V is one dimensional. The Iwahori Hecke algebra acts on this space via a character. We determine the value of this character on a particular Hecke algebra element and use this action to determine in full the Whittaker function associated with an Iwahori fixed vector generalizing a result of Baruch and Purkait for $GL_2(F)$. This result is essentially a Casselman-Shalika formula analogue for Iwahori spherical vectors. We will demonstrate what this Whittaker function is explicitly and, time permitting, we will discuss how we can use it to compute the Whittaker function attached to a Steinberg representation of $SL_n(F)$.

Joint work with Ehud Moshe Baruch.

14. Odeya Katz (Ariel University)- Generalizations of the lamplighter group

Abstract: The standard lamplighter group $\mathbb{Z}_2 \wr \mathbb{Z}$ can be described by viewing the group as acting on a doubly infinite sequence of street lamps denoted by $\ldots \mathrm{l}_{-2}, \mathrm{l}_{-1}, \mathrm{l}_0, \mathrm{l}_1, \mathrm{l}_2 \ldots$ where each lamp may be switched on or switched off, such that finitely many lamps are switched on, and the lamplighter is standing at one of the lamps.

In my talk, I consider interesting generalizations of the standard lamplighter group and interesting properties of the received groups by considering the lamplighter configurations of the groups.

15. Noam Kimmel (Tel Aviv University) – Zeros of Poincaré series

Abstract: Modular forms are functions on the upper half complex plane which possess interesting symmetries. Since their discovery in the beginning of the twentieth century, these functions have played an integral role in number theory and have found numerous applications in other fields such as computer science and mathematical physics.

For distinguished modular forms, it is an interesting problem to try and understand the location of their zeros. In this talk, I will focus on the zeros of a special family of modular forms known as the Poincaré series, which has been central to the analytic theory of modular forms. This family, denoted by $P(k,m)$, is defined by two parameters: a weight k and an index m. Rankin investigated the zeros of $P(k,m)$ when m is constant and k tends to infinity, showing that in this case almost all zeros lie on the unit arc $|z|=1$. I will extend this investigation to cases where the index m grows with the weight k, revealing new patterns in the zeros' locations.

16. Rishi Kumar (Ben Gurion University) – Kepler Sets of Linear Recurrence Sequences

Abstract: A linear recurrence sequence of order d is a sequence $\{a(n): n = 0,1,2 \dots\}$ for which there are coefficients $c(0), \dots, c(d)$ so that for all n, $c(0)a(n) + \cdots + c(d)a(n+d) = 0$. Examples include the Fibonacci sequence and the Lucas sequence. The Kepler set of the recurrence sequence is the closure of the consecutive ratios $a(n+1)/a(n)$.

Garcia and Luca (2016) proved that the full ratio set of the Fibonacci sequence $F(n)/F(m)$ is dense in Q. This result has been extended to certain classes of integer-valued recurrence sequences. In this talk, we will study Kepler sets of recurrence sequences with coefficients over Q_p. In particular, we will strengthen the result of Garcia and Luca.

17. Avichai Marmor (Bar-Ilan University) – Maximal Gallai colorings and perfect matchings

Abstract: In 1975, Erdos, Simonovits and Sos proved a fundamental result in anti-Ramsey theory. They showed that the maximal number of colors in an edge coloring of the complete graph K_n, without the existence of a rainbow triangle (a triangle with three different colored edges), is n-1. This seminal paper sparked extensive research and inspired hundreds of follow-up studies, leading to generalizations of the result to non-complete graphs, matroids, root systems, and other related areas. These edge colorings of K_n without a rainbow triangle are commonly referred to as Gallai colorings, named after Gallai, who analyzed a closely related concept known as comparability graphs.

In this talk, we will explore enumerative and structural questions related to Gallai colorings and reveal surprising connections between Gallai colorings and perfect matchings. Time permitting, we will also discuss a related open problem involving Catalan numbers.

The talk is based on joint work with Ron Adin and Yuval Roichman.

18. Barak Ohana (Hebrew University) – Equations in Hyperbolic(-esque) Groups

Abstract: Given a group Γ, we will discuss properties of systems of equations over Γ. More specifically, a group Γ is called Equationally Noetherian if every set of equations is equivalent to a finite subset of it. We will present this notion and discuss its connection to geometric properties of Γ, namely, hyperbolic structures on which Γ acts.

We will present a new result which shows that if Γ is strictly acylindrical colorable hierarchically hyperbolic group, then it is equationally Noetherian.

19. Adi Ostrov (Bar-Ilan Unversity) – Fibonacci Numbers as Special Values of Polynomials

Abstract: Is there a rational function $g(x) \in Q(x)$ of degree ≥ 2 whose image $g(Q)$ contains infinitely many elements from the Fibonacci sequence?

Is there an irreducible polynomial $P(t, x)$ over $Q(t)$ for which $P(F_n, x)$ is reducible over Q for infinitely many n?

Unlikely intersections principles imply that if such polynomials exist, they must satisfy some strong geometric conditions or exhibit some global phenomena.

In the lecture we discuss these geometric conditions and classify the polynomials which satisfy them.

20. Idan Pazi (Weizmann Institute) – An Oscillators-Barrier Hamiltonian Impact System

Abstract: We investigate the dynamics of a particle moving on a plane under the influence of a unimodal separable potential with the particle elastically impacting a thin horizontal barrier.

The energy level sets of this system are foliated into surfaces that are topologically conjugate to a genus 2 surface, rendering the motion to be only pseudo-integrable, not integrable in the Arnold-Liouville sense, i.e., not corresponding to a rotation on a torus. The return map of the motion to a given section of the phase space is an interval exchange map.

We explore the effects of introducing a small perturbation, a small coupling between the directions of motion, which breaks the separability assumption. The return map can now be viewed as a family of interval exchange maps. We examine the cases where resonant quasi-periodic motion arises under small perturbation and when chaotic motion emerges.

Joint work with Prof. Vered Rom-Kedar.

21. Roei Raveh (Tel Aviv University) – Zeros of the Miller basis of cusp forms

Abstract: Modular forms are holomorphic functions in the upper half plane which transform nicely under the action of $SL(2, Z)$ by Mobius transformations. Modular forms play a huge role in modern analytic number theory, as their Fourier coefficients carry arithmetical information.

Each modular form has a weight k; for a non-zero modular form of weight k, there are about $k/12$ zeros in the fundamental domain of the action of $SL(2, Z)$ on the upper half-plane.

In this talk, we will discuss the zeros of the Miller basis of modular forms, a natural basis for the linear space of modular forms of a given weight. For sufficiently large weights, the zeros in the fundamental domain of the Miller basis, all lie on the circular part of the boundary of the fundamental domain. This result joins previous results for different families of modular forms whose zeros also lie on the circular part of the boundary of the fundamental domain.

No previous knowledge of modular forms will be assumed.

22. Daniel Rosenberg (Ariel University) – Resilience of the quadratic Littlewood-Offord problem

Abstract: We study the statistical resilience of high-dimensional data. Our results provide estimates as to the effects of adversarial noise over the anti-concentration properties of the Rademacher set-polynomials $f(\xi_1, \dots, \xi_n) := \sum_{S\subseteq[n];|S|\le d} f_S \prod_{i\in S} \xi_i$, where f is a fixed set-polynomial of rank d and ξ is a conformal Rademacher vector. Specifically, we pursue the question of how many adversarial sign-flips can ξ sustain without ''inflating'' $\sup_{x\in R} \Pr[f(\xi_1, \dots, \xi_n) = x]$ and thus ''de-smoothing'' the original distribution, resulting in a more ''grainy'' and adversarially biased distribution.

For bilinear forms, we are able to provide better probabilistic guarantees compared with the general case. These bounds will be the focal point of our talk. Our probabilistic lower bound guarantees for the resilience of the quadratic Rademacher chaos are instance dependent and are dominated by various norms associated with the data; hence, our guarantees can be efficiently computed from the data alone.

Joint work with Elad Aigner-Horev and Roi Weiss.

23. Gilad Sofer (Technion) – Spectral properties of almost periodic quantum graphs

Abstract: Sturmian Hamiltonians appear in mathematical physics as popular models for one-dimensional quasicrystals. This family of discrete one-dimensional Schrodinger operators, which includes the well-known Fibonacci Hamiltonian, is widely studied for its interesting spectral properties.

In this talk, we discuss the analogues of these systems in the framework of almost periodic networks. Specifically, we replace the family of Schrodinger operators on Z with a family of almost periodic metric graphs, whose local geometric structure is determined by Sturmian sequences. We equip these graphs with a natural Laplacian, and show that they share many spectral properties with their discrete Sturmian counterparts. For instance, their spectrum is a generalized Cantor set of Lebesgue measure zero, obtained as the limit of an appropriate sequence of periodic approximations. We also highlight several unique features of these models that do not occur for the standard Sturmian Hamiltonians.

Based on joint work with Ram Band.

24. Ohad Sheinfeld (Bar Ilan University) – Squares of conjugacy classes of S_n

Abstract: We study covering numbers of subsets of the symmetric group S_n that exhibit closure under conjugation, known as *normal* sets. We show that for any $\epsilon > 0$, there exists n_0 such that if $n > n_0$ and A is a conjugacy class of the symmetric group S_n of density $\geq e^{-n^{2/5-\epsilon}}$, then $A^2 = A_n$. This improves upon a seminal result of Larsen and Shalev (Inventiones Math., 2008), with our $2/5$ in the double exponent replacing their $1/4$.

Our proof strategy combines two types of techniques. The first is 'traditional' techniques rooted in character bounds and asymptotics for the Witten zeta function, drawing from the foundational works of Liebeck--Shalev, Larsen--Shalev, and more recently, Larsen--Tiep. The second is a sharp hypercontractivity theorem in the symmetric group, which was recently obtained by Keevash and Lifshitz. This synthesis of algebraic and analytic methodologies not

only allows us to attain our improved bounds but also provides new insights into the behavior of general independent sets in normal Cayley graphs over symmetric groups.

Based on a joint work with Nathan Keller and Noam Lifshitz.

25. Lior Tenenbaum (Technion) – Periodic approximation of substitution subshifts

Abstract: In studying higher dimensional Schrödinger operators of quasicrystals, one is led to find suitable periodic approximations. This means, in particular, that the spectrum converges as a set to the limiting spectrum. It turns out that for this to hold, the convergence of the underlying dynamical systems is exactly what is needed. This is the starting point of the present talk.

We focus on aperiodic subshifts defined through symbolic substitutions. These substitution subshifts provide models of aperiodic ordered systems. We find natural sequence candidates of subshifts to approximate the aforementioned substitution subshift. We characterize when these sequences converge, and if so at what asymptotic rate. Some well-known examples of substitution subshifts are discussed during the talk. We will also discuss the motivation for this characterization, arising from an attempt to study higher dimensional quasi-crystals.

Based on a Joint work with Ram Band, Siegfried Beckus and Felix Pogorzelski.

26. Shachar Weinbaum (Technion and Tel Aviv University) – The Ramanujan Machine and the Hypergeometric Conservative Matrix Field

Abstract: In number theory, a core and difficult question is that of irrationality. in modern irrationality proofs, one often studies continued fractions of polynomial sequences, like the one used in Apéry's original proof of the irrationality of $\zeta(3)$. Since 2018, the Ramanujan Machine team has used algorithms to generate and study such continued fractions experimentally. These could be encapsulated by a Conservative Matrix Field: a set of matrices defined over a lattice, constituting an Eilenberg–MacLane 1-cocycle of Z^d.

In this talk, we will present the Conservative Matrix Field (CMF). In addition, we introduce a construction of CMFs from Hypergeometric Functions and their generalizations. We will demonstrate their utility in irrationality proofs, identity proofs, symbolic computation, and series regularization.

27. Johanna Weinberger (Technion) – SDEs Involving the Local Time of the Unknown Process Driven by Stable Processes

Abstract: Stochastic differential equations involving the local time of the unknown process with Brownian forcing were thoroughly discussed by Jean-François Le Gall in his seminal paper from 1984. A special case of these equations is of the form

$X_t = x_0 + \int_R \ell_t^x \mu(dx) + B_t,\ \ t \geq 0,$ where B is a standard Brownian motion, $x_0 \in R$, μ is a Radon measure and ℓ is the local time of X given by Tanaka's formula. We formulate an analogous equation in dimension $d = 1$, where B is replaced by a symmetric, α-stable process

L with $\alpha \in (1,2)$, and discuss weak and strong existence and uniqueness of solutions, as well as the equivalence to singular SDEs with drift μ.

To this end, we define a local time ℓ by deriving a Tanaka-type formula for the process L that is perturbed by a process of finite variation. We show that ℓ coincides with the occupation density of X under mild assumptions on the drift μ.

The talk is based on joint work with Leonid Mytnik.

28. Andrey Yurkov (Bar-Ilan University) – Nonlinear maps preserving the homogeneous polynomial

Abstract: The investigations of linear maps between matrix spaces that preserve different matrix invariants go back to Frobenius. This research was continued by Schur, Dieudonné, Dynkin and others.

In recent works, the linearity of the map considered has been changed to a slightly weaker condition, and one linear map has been replaced for two maps, ϕ and ψ. That is, if the matrix invariant is represented as a polynomial $P \in \mathbb{F}[x_1, \ldots, x_n]$, then for $\phi, \psi: \mathbb{F}^n \to \mathbb{F}^n$ the condition is that $P(\boldsymbol{x} + \lambda\boldsymbol{y}) = P\big(\phi(\boldsymbol{x}) + \lambda\psi(\boldsymbol{y})\big)$, for all $\lambda \in \mathbb{F}$ and $x, y \in \mathbb{F}^n$.

We provide the characterization of all such ϕ and ψ in the case where $\mathbb{F}$ is an infinite field and P is a homogeneous polynomial satisfying certain restrictions. This characterization generalizes the existing results about the matrix determinant, elementary symmetric polynomials and other homogeneous polynomial functions of matrix coefficients.