ALGEBRAIC K-THEORY, NUMBER THEORY, GEOMETRY, AND ANALYSIS pdf

1: Group theory - Wikipedia

Algebraic K-Theory, Number Theory, Geometry and Analysis: Proceedings of the International Conference held at Bielefeld, Federal Republic of Germany. in Mathematics (English and French Edition) (French) 1st Edition.

Physics[edit] In physics , groups are important because they describe the symmetries which the laws of physics seem to obey. Physicists are very interested in group representations, especially of Lie groups, since these representations often point the way to the "possible" physical theories. Chemistry and materials science[edit] In chemistry and materials science , groups are used to classify crystal structures , regular polyhedra, and the symmetries of molecules. Molecular symmetry is responsible for many physical and spectroscopic properties of compounds and provides relevant information about how chemical reactions occur. In order to assign a point group for any given molecule, it is necessary to find the set of symmetry operations present on it. The symmetry operation is an action, such as a rotation around an axis or a reflection through a mirror plane. In other words, it is an operation that moves the molecule such that it is indistinguishable from the original configuration. In group theory, the rotation axes and mirror planes are called "symmetry elements". These elements can be a point, line or plane with respect to which the symmetry operation is carried out. The symmetry operations of a molecule determine the specific point group for this molecule. Water molecule with symmetry axis In chemistry , there are five important symmetry operations. The identity operation E consists of leaving the molecule as it is. This is equivalent to any number of full rotations around any axis. This is a symmetry of all molecules, whereas the symmetry group of a chiral molecule consists of only the identity operation. Rotation around an axis Cn consists of rotating the molecule around a specific axis by a specific angle. Other symmetry operations are: History of group theory Group theory has three main historical sources: Early results about permutation groups were obtained by Lagrange , Ruffini , and Abel in their quest for general solutions of polynomial equations of high degree. In geometry, groups first became important in projective geometry and, later, non-Euclidean geometry. Galois , in the s, was the first to employ groups to determine the solvability of polynomial equations. Arthur Cayley and Augustin Louis Cauchy pushed these investigations further by creating the theory of permutation groups. The second historical source for groups stems from geometrical situations. In an attempt to come to grips with possible geometries such as euclidean , hyperbolic or projective geometry using group theory, Felix Klein initiated the Erlangen programme. Sophus Lie , in , started using groups now called Lie groups attached to analytic problems. Thirdly, groups were, at first implicitly and later explicitly, used in algebraic number theory. The different scope of these early sources resulted in different notions of groups. The theory of groups was unified starting around Since then, the impact of group theory has been ever growing, giving rise to the birth of abstract algebra in the early 20th century, representation theory , and many more influential spin-off domains. The classification of finite simple groups is a vast body of work from the mid 20th century, classifying all the finite simple groups.

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2: Research areas | Graduate Program | Mathematics at the University of Virginia

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3: Algebraic K-theory - Wikipedia

Sciences on Applications of Algebraic K-Theory to Algebraic Geometry and Number Theory was held at the University of Colorado, Boulder on June , with support from the National Science Foundation Grant MCS

Course descriptions Research areas The Mathematics Department at the University of Virginia offers graduate students the opportunity to do research in a wide range of specialties. To help students with the daunting task of planning their multi-year program, in this guide we describe standard routes through the main research areas that students can currently pursue. We expect most students to follow one of these paths. For convenience, we have grouped these within Programs in Algebra, Analysis, Topology, and the History of Mathematics. However, it is to be emphasized that there is much interaction between these, and a course of study might easily fall between areas. Furthermore, research areas undergo constant change due to changing faculty and student interests, and to new faculty joining the Department. Finally, there are a number of possible courses of study not listed here that may involve collaboration with faculty from other departments. First Year First Semester: Besides taking the sequence MATH , , , in their first two years, students with interests in algebra are required - within the first two years - to take at least one additional course in the specialized area of algebra which they expect to follow. The additional course s may be an independent reading course taken under the supervision of a faculty member. Research Seminar Algebra students are also required to take and to participate actively in MATH Algebra Seminar every semester after the first year. In the first semester of the second year, students contemplating working in algebra should contact a faculty member regarding a topic for a literature survey and, during the second semester, give a short expository talk in the Algebra Seminar. Second-Year Proficiency Exam In the second year, students take the Second-Year Proficiency Exam, which, in algebra, consists of a conversation with a panel of faculty members on the material of two or three second-year algebra courses taken by the student, and on the bibliographical research done by the student and presented in MATH Rapinchuk ; Research in this area focuses on structural, combinatorial and homological properties of linear groups over general rings with a special emphasis on arithmetic rings i. Topics include the normal subgroup structure of the groups of rational points of algebraic groups and of their important subgroups, finiteness properties of arithmetic groups in positive characteristic, the rigidity of representations of finitely generated groups and building theory, in particular, group actions on spherical, affine, and twin buildings. Wang ; Representation theory deals with representations of algebraic and associated finite groups, associative and Lie algebras, and connections with algebraic geometry and mathematical physics. Topics include representations of reductive algebraic groups in positive characteristic with applications to finite groups of Lie type, quantum groups and Hecke algebras, quasi-hereditary algebras and vertex algebras. This work used methods from the theory of algebraic groups and algebraic geometry, Lie algebras, and homological algebra. Huneke ; Commutative algebra studies the space of solutions of polynomial and power series equations in many variables, often by creating a "generic" solution space, and investigating the properties of this space, and its specializations and deformations. In the early 20th century, commutative algebra was born out of three classical fields: Today it retains connections to all of these areas, as well as many other areas such as combinatorics, homological algebra, representation theory, computational algebra, singularity theory, and algebraic statistics. One of the most important techniques in modern commutative algebra is that of reduction to characteristic p, and the study and classification of singularities through invariants coming from this reduction. Morse ; 2 Graduate Program in Analysis Graduate research in analysis is organized into the following areas: MATH Functional Analysis I Additional courses and requirements depend on the specific research area selected by a student, as specified below. General exam The General Exam in Analysis has two parts: For students planning to work in analysis, the second part of the general exam should fit with the area they are pursuing. Research Seminars Students in analysis in the second year and beyond are expected to participate in one of the analysis research seminars. These seminars are an important component of the graduate program, and are student-oriented. They aim to expand upon material covered in the various courses and to prepare students for independent reading of research papers. In the first semester of the second year, students contemplating working in an area of analysis should contact a faculty member regarding a topic for a literature survey, and, during the second semester, give a short talk in the appropriate seminar. Second-Year Proficiency Exam Also in the second year, students take the Second-Year Proficiency Exam, which, in analysis, consists of a conversation with a panel of faculty members on the material from two or three second-year analysis courses, and and on the bibliographical research done by the student for their seminar presentation. Di Plinio ; J. Grujic ; This area focuses on the qualitative study of solutions of differential equations: Particular emphasis is placed on equations arising in mathematical physics and related areas of applied mathematics. Topics of study include fluid dynamics, linear and nonlinear elasticity and wave propagation, harmonic analysis, dynamical systems, and control theory. The mathematical methods used draw from real and complex analysis, functional analysis, harmonic analysis, ordinary and partial differential equations, basic differential geometry, and probability. Petrov ; Our research in mathematical physics is concerned with the spectral and scattering theory for Schroedinger operators in quantum mechanics, equilibrium and non-equilibrium statistical mechanics, and topics in classical mechanics. The mathematical methods needed include: Sherman ; Our research on Hilbert space operators draws broadly from functional analysis and has two main interrelated strands. One is rooted in complex function theory and concerns composition, Toeplitz, and other operators on spaces of analytic functions. The other studies algebraic structures of operators: Students should take their Ph. Petrov ; Probability is the mathematical theory of random events and random variables. These are typically offered in the Spring and Fall respectively, so that students can begin in the Spring of their first year after taking Algebraic Topology Low-Dimensional Topology and Geometry We must emphasize that these areas have a lot in common, so the subdivision into "algebraic" and "geometric" is not always precise. Second Year First Semester: In addition, during the second year students should take at least one additional topology course. Besides taking the sequence MATH or , , , , students with interests in topology are requiredâ€”within the first two yearsâ€”to take at least one additional course in the specialized area or track of topology see below which they expect to follow. These additional courses may be independent reading courses taken under the supervision of a faculty member. Research seminars are an important component of the graduate program. Participation in them gives students an opportunity to be exposed to the current research in topology. In the first semester of the second year, students contemplating working in topology should contact a faculty member regarding a topic for a literature survey and, during the second semester, give a short expository talk in the Topology or Geometry seminar. Second-Year Proficiency Exam In the second year, students take the Second-Year Proficiency Exam, which, in topology, consists of a conversation with a panel of faculty members on the material of two or three topology courses taken by the student during the second year, and on the bibliographical research done by the student and presented in MATH Kuhn ; The subject of algebraic topology is the interplay between topology and algebra. One associates algebraic objects, e. Research in this area requires a good understanding of both topology and algebra. Areas of particular interest to faculty include homotopical algebra and homotopy as organized by the calculus of functors, group cohomology and its connections to representation theory and algebraic K-theory, and the study of complex oriented cohomology theories. There are deep connections with many parts of algebra, including algebraic geometry and number theory, and mathematical physics. Mark ; The central subject of geometric topology is the theory of manifolds, their classification, and study of their geometric properties. Research areas represented by the faculty include knot theory, quantum invariants of three-dimensional manifolds, geometric and differential four-dimensional topology, gauge theory, groups acting on manifolds, hyperbolic geometry, and moduli spaces of geometric structures. This area has deep connections with algebraic topology, representation theory, geometric analysis and mathematical physics. Parshall ; The graduate program in the history of mathematics includes a component in the history of science taken within the Department of History. Students in the program must satisfy all of the requirements for the

Ph. In particular, they must complete the coursework in mathematics and perform satisfactorily on General Examinations in two areas before they are permitted to proceed toward the doctorate. Strong reading competency in either French or German is required for admission into the program, with strong reading competency required in the other language by the time dissertation research begins. Program Coursework The following is typical for a student in the graduate program in the history of mathematics: General exams are taken at the end of the summer after the first year. The summer after the second year involves directed readings geared toward the isolation of an eventual dissertation topic. Third Year and Beyond Additional mathematics courses to complete the number of hours required for the degree chosen in consultation with the adviser , and any additional courses as needed in, for example, language s , history, or philosophy. It generally takes place before the end of the third year. Successful defense of the proposal represents "permission to proceed" to the dissertation phase of the program. The proposal is a written document generally thirty to forty pages in length, exclusive of bibliography that is presented in a public forum.

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4: User Amitesh Datta - Mathematics Stack Exchange

The Seminar on Algebraic K-theory and Algebraic Number Theory was held at the East- West Center in Honolulu, Hawaii on January , with support from the National Science Foundation, Grant DMS and the Japan Society for the Promotion of Science (JSPS).

In particular, John Tate was able to prove that K2 Q is essentially structured around the law of quadratic reciprocity. Higher K-groups[edit] In the late s and early s, several definitions of higher K-theory were proposed. Nobile and Villamayor also proposed a definition of higher K-groups. Their K-groups are now called KVn and are related to homotopy-invariant modifications of K-theory. Much later, it was discovered by Nesterenko and Suslin [18] and by Totaro [19] that Milnor K-theory is actually a direct summand of the true K-theory of the field. Specifically, K-groups have a filtration called the weight filtration, and the Milnor K-theory of a field is the highest weight-graded piece of the K-theory. Additionally, Thomason discovered that there is no analog of Milnor K-theory for a general variety. This modification was called the plus construction. Not only did this recover K1 and K2, the relation of K-theory to the Adams operations allowed Quillen to compute the K-groups of finite fields. Additionally, it did not give any negative K-groups. Since K0 had a known and accepted definition it was possible to sidestep this difficulty, but it remained technically awkward. Conceptually, the problem was that the definition sprung from GL, which was classically the source of K1. Because GL knows only about gluing vector bundles, not about the vector bundles themselves, it was impossible for it to describe K0. Where Grothendieck worked with isomorphism classes of bundles, Segal worked with the bundles themselves and used isomorphisms of the bundles as part of his data. This results in a spectrum whose homotopy groups are the higher K-groups including K0. In the spring of , Quillen found another approach to the construction of higher K-theory which was to prove enormously successful. This new definition began with an exact category , a category satisfying certain formal properties similar to, but slightly weaker than, the properties satisfied by a category of modules or vector bundles. From this he constructed an auxiliary category using a new device called his " Q-construction. If C is an abelian category, then QC is a category with the same objects as C but whose morphisms are defined in terms of short exact sequences in C. This yielded the correct K0 and led to simpler proofs, but still did not yield any negative K-groups. All abelian categories are exact categories, but not all exact categories are abelian. Because Quillen was able to work in this more general situation, he was able to use exact categories as tools in his proofs. This technique allowed him to prove many of the basic theorems of algebraic K-theory. K-theory now appeared to be a homology theory for rings and a cohomology theory for varieties. However, many of its basic theorems carried the hypothesis that the ring or variety in question was regular. One of the basic expected relations was a long exact sequence called the "localization sequence" relating the K-theory of a variety X and an open subset U. Quillen was unable to prove the existence of the localization sequence in full generality. G-theory had been defined early in the development of the subject by Grothendieck. Grothendieck defined G0 X for a variety X to be the free abelian group on isomorphism classes of coherent sheaves on X, modulo relations coming from exact sequences of coherent sheaves. In the categorical framework adopted by later authors, the K-theory of a variety is the K-theory of its category of vector bundles, while its G-theory is the K-theory of its category of coherent sheaves. Not only could Quillen prove the existence of a localization exact sequence for G-theory, he could prove that for a regular ring or variety, K-theory equaled G-theory, and therefore K-theory of regular varieties had a localization exact sequence. Since this sequence was fundamental to many of the facts in the subject, regularity hypotheses pervaded early work on higher K-theory. A closely related construction was found by C. Whitehead torsion was eventually reinterpreted in a more directly K-theoretic way. This reinterpretation happened through the study of h-cobordisms. If M and N are not assumed to be simply connected, then an h-cobordism need not be a cylinder. The s-cobordism theorem, due independently to Mazur, [26] Stallings, and Barden, [27] explains the general situation: This generalizes the h-cobordism theorem because the simple connectedness hypotheses imply that the relevant Whitehead group is trivial. In fact the s-cobordism theorem implies that there is a bijective correspondence between isomorphism classes of h-cobordisms and elements of the Whitehead group. An obvious question associated with the existence of h-cobordisms is their uniqueness. The natural notion of equivalence is isotopy. Jean Cerf proved that for simply connected smooth manifolds M of dimension at least 5, isotopy of h-cobordisms is the same as a weaker notion called pseudo-isotopy. Consideration of these questions led Waldhausen to introduced his algebraic K-theory of spaces. In order to fully develop A-theory, Waldhausen made significant technical advances in the foundations of K-theory. Algebraic topology and algebraic geometry in algebraic K-theory[edit] Quillen suggested to his student Kenneth Brown that it might be possible to create a theory of sheaves of spectra of which K-theory would provide an example. The sheaf of K-theory spectra would, to each open subset of a variety, associate the K-theory of that open subset. Brown developed such a theory for his thesis. Simultaneously, Gersten had the same idea. This is now called the Brownâ€”Gersten spectral sequence.

5: Generating the cokernel of K3Z! K3F7 â€” Northwestern Scholars

Charles Weibel (algebraic K-theory, algebraic geometry and homological algebra) Other areas of faculty research with roots in or connections to algebra include Discrete Mathematics, Lie Theory and Representation Theory, Logic, Number Theory.

Sergei Ivanov â€” Combinatorial group theory and its applications. Ilya Kapovich â€” Geometric group theory and geometric topology. Sheldon Katz â€” Algebraic geometry, string theory. Rinat Kedem â€” Mathematical physics, representation theory of infinite dimensional Lie algebras, quantum groups, and vertex algebras, integrable models statistical mechanics and quantum field theory. Randy McCarthy â€” Algebraic K-theory, algebraic topology. Igor Mineyev â€” Geometric group theory, large-scale geometry, hyperbolic groups, various types of homology and cohomology of groups and spaces, topology of manifolds and cell complexes, metric conformal structures, metric geometry. Thomas Nevins â€” Algebraic geometry, geometric representation theory, noncommutative algebra, mathematical physics Bruce Reznick â€” Combinatorial methods in algebra, analysis, number theory, combinatorics, geometry. Alexander Yong â€” Combinatorial aspects of algebra and geometry; algebraic combinatorics. Laura Escobar â€” Combinatorial aspects of algebra and algebraic geometry. Jeremiah Heller â€”Motivic homotopy theory, algebraic cycles and K-theory. Emeriti Faculty Everett Dade â€” Representation theory, finite groups, ring theory. Grayson â€” Algebraic K-theory, motivic cohomology, algebraic geometry, number theory, computational algebra. Griffith â€” Commutative algebra, polynomials in several variables, homological algebra, ring theory. Janusz â€” Representation theory of finite groups, algebraic number theory, Brauer groups, ring theory. McCulloh â€” Algebraic number theory, Galois module structure. Anand Pillay â€” Model theory and algebra; stability theory, model theory of groups and fields with applications, differential fields. Ranga Rao â€” Reductive groups and their representations and harmonic analysis on homogeneous spaces. Robinson â€” Group theory, especially infinite soluble groups, permutability of subgroups, chain conditions; Connections with homological algebra; Algorithms for groups. Schupp â€” Group theory, logic, formal language theory and their interconnections. Ullom â€” Algebraic number theory. Walter â€” Group theory. Weichsel â€” Algebraic graph theory, graph theory, combinatorial group theory, combinatorics.

6: Faculty Research - Pure Mathematics - MSCS@UIC

Algebraic K-theory is a subject area in mathematics with connections to geometry, topology, ring theory, and number www.enganchecubano.comric, algebraic, and arithmetic objects are assigned objects called K-groups.

7: People | Department of Mathematics

Stein, Michael R. / Generating the cokernel of K3Z! www.enganchecubano.comaic K-theory, Number Theory, Geometry and Analysis, Lecture Notes in Math. Berlin & New York: Springer-Verlag,

8: Standing Faculty | Department of Mathematics

An Algebraic Introduction to K-Theory This book is an introduction to K-theory and a text in www.enganchecubano.com two roles are entirely compatible. On the one hand, nothing more than the basic algebra of groups.

9: Algebra | Mathematics at Illinois

Thomas Nevins â€” Algebraic geometry, geometric representation theory, noncommutative algebra, mathematical

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physics Bruce Reznick â€” Combinatorial methods in algebra, analysis, number theory, combinatorics, geometry.

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