CHARACTER VARIETY OF REPRESENTATIONS OF A FINITELY GENERATED GROUP IN SL_2

KYOJI SAITO

This is a partial exposition of [S4, S5, S6], which study the space of representations of a (finitely generated) group Γ in SL_2 and GL_2 in an attempt of its application in geometry: Teichmüller spaces, knot theory, hyperbolic manifolds, moduli spaces, $\cdots$, etc. (see for instance, [A], [Be], [Br], [C-C-G-L-S], [C-S], [F-K], [G], [H], [H-L-M], [H-K], [J-W], [K], [Kj], [Ko], [Kr], [Ma], [Mu], [N-Z], [O], [S], [S-S], [T], [W], [We], [Wo], [Y], $\cdots$, etc). For simplicity, we omit the case for GL_2 in the present exposition. Let us explain the main result of the present paper.

Let Γ be a group. The purpose of the present paper is to introduce the character variety $\mathrm{Ch}(\Gamma, SL_2)$ in order to parameterize conjugacy classes of representations of Γ in SL_2 in a functorial way. At first, the character variety is introduced as a scheme over $\mathbb{Z}$, independent of the coefficient ring of representations in question. Then, the scalar field is specialized to $\mathbb{R}$ to obtain results on representations in $SL_2(\mathbb{R})$ and in $SU(2)$ with respect to the classical topology. Let us explain this briefly.

Let $\mathrm{Hom}(\Gamma, SL_n)$ be the functor $R \in \{\text{commutative rings with } 1\} \longmapsto \mathrm{Hom}(\Gamma, SL_n(R)) \in \{\text{sets}\}$. The functor is representable (see §1.3 Lemma) and so, for an abuse of notation, we denote by the same $\mathrm{Hom}(\Gamma, SL_n)$ the scheme over $\mathbb{Z}$ representing the functor. The group scheme PGL_n acts on $\mathrm{Hom}(\Gamma, SL_n)$. Whether the universal categorical quotient $\mathrm{Hom}(\Gamma, SL_n)//PGL_m$ (Mumford [Mu1]) defined over $\mathbb{Z}$ exists or not seems to be a hard and unsolved question. Instead of asking directly for the quotient space, we introduce i) the *character variety* $\mathrm{Ch}(\Gamma, SL_2)$ together with its *discriminant subvariety* D_Γ as schemes over $\mathbb{Z}$ abstractly, and ii) the PGL_2-*invariant morphism* π_Γ: $\mathrm{Hom}(\Gamma, SL_2) \longrightarrow \mathrm{Ch}(\Gamma, SL_2)$, for which we prove that i) *the restriction of π_Γ on the complement of $\pi_\Gamma^{-1}(D_\Gamma)$ is a principal PGL_2-bundle with respect to the etal topology, and ii) the inverse image $\pi_\Gamma^{-1}(D_\Gamma)$ is a subfunctor of $\mathrm{Hom}(\Gamma, SL_2)$ consisting of abelian or reducible representations*. This implies that the complement $\mathrm{Hom}^*(\Gamma, SL_2) := \mathrm{Hom}(\Gamma, SL_2) \backslash \pi_\Gamma^{-1}(D_\Gamma)$ consists of absolutely irreducible representations, and that $\mathrm{Hom}^*(\Gamma, SL_2)$ has the universal categorical quotient space $\mathrm{Ch}^*(\Gamma, SL_2) := \mathrm{Ch}(\Gamma, SL_2) \backslash D_\Gamma$ defined over $\mathbb{Z}$. Then the result is specialized

Sl2 Representations Of Finitely Presented Groups

Robert R. Redfield

Sl2 Representations Of Finitely Presented Groups:

$SL(2)$ Representations of Finitely Presented Groups Gregory W. Brumfiel,H. M. Hilden,1995 This book is essentially self contained and requires only a basic abstract algebra course as background The book includes and extends much of the classical theory of SL 2 representations of groups Readers will find SL 2 Representations of Finitely Presented Groups relevant to geometric theory of three dimensional manifolds representations of infinite groups and invariant theory Features A new finitely computable invariant H p associated to groups and used to study the SL 2 representations of p Invariant theory and knot theory related through SL 2 representations of knot groups **Finitely Presented Groups** Volker Diekert,Martin Kreuzer,2024-10-07 This book contains surveys and research articles on the state of the art in finitely presented groups for researchers and graduate students Overviews of current trends in exponential groups and of the classification of finite triangle groups and finite generalized tetrahedron groups are complemented by new results on a conjecture of Rosenberger and an approximation theorem A special emphasis is on algorithmic techniques and their complexity both for finitely generated groups and for finite Z algebras including explicit computer calculations highlighting important classical methods A further chapter surveys connections to mathematical logic in particular to universal theories of various classes of groups and contains new results on countable elementary free groups Applications to cryptography include overviews of techniques based on representations of p groups and of non commutative group actions Further applications of finitely generated groups to topology and artificial intelligence complete the volume All in all leading experts provide up to date overviews and current trends in combinatorial group theory and its connections to cryptography and other areas *Varieties of Representations of Finitely Generated Groups* Alexander Lubotzky,Andy R. Magid,Andy Roy Magid,1985 The n dimensional representations over an algebraically closed characteristic zero field k of a finitely generated group are parameterized by an affine algebraic variety over k The tangent spaces of this variety are subspaces of spaces of one cocycles and thus the geometry of the variety is locally related to the cohomology of the group The cohomology is also related to the prounipotent radical of the proalgebraic hull of the group This paper exploits these two relations to compute dimensions of representation varieties especially for nilpotent groups and their generalizations It also presents the foundations of the theory of representation varieties in an expository self contained manner *Lie Groups, Geometry, and Representation Theory* Victor G. Kac,Vladimir L. Popov,2018-12-12 This volume dedicated to the memory of the great American mathematician Bertram Kostant May 24 1928 February 2 2017 is a collection of 19 invited papers by leading mathematicians working in Lie theory representation theory algebra geometry and mathematical physics Kostant s fundamental work in all of these areas has provided deep new insights and connections and has created new fields of research This volume features the only published articles of important recent results of the contributors with full details of their proofs Key topics include Poisson structures and potentials A Alekseev A Berenstein B Hoffman Vertex algebras T Arakawa K Kawasetsu Modular irreducible representations of

semisimple Lie algebras R Bezrukavnikov I Losev Asymptotic Hecke algebras A Braverman D Kazhdan Tensor categories and quantum groups A Davydov P Etingof D Nikshych Nil Hecke algebras and Whittaker D modules V Ginzburg Toeplitz operators V Guillemin A Uribe Z Wang Kashiwara crystals A Joseph Characters of highest weight modules V Kac M Wakimoto Alcove polytopes T Lam A Postnikov Representation theory of quantized Gieseker varieties I Losev Generalized Bruhat cells and integrable systems J H Liu Y Mi Almost characters G Lusztig Verlinde formulas E Meinrenken Dirac operator and equivariant index P Paradan M Vergne Modality of representations and geometry of groups V L Popov Distributions on homogeneous spaces N Ressayre Reduction of orthogonal representations J P Serre **Modular Representation Theory of Finite Groups** Peter Schneider,2012-11-27 Representation theory studies maps from groups into the general linear group of a finite dimensional vector space For finite groups the theory comes in two distinct flavours In the semisimple case for example over the field of complex numbers one can use character theory to completely understand the representations This by far is not sufficient when the characteristic of the field divides the order of the group Modular Representation Theory of finite Groups comprises this second situation Many additional tools are needed for this case To mention some there is the systematic use of Grothendieck groups leading to the Cartan matrix and the decomposition matrix of the group as well as Green s direct analysis of indecomposable representations There is also the strategy of writing the category of all representations as the direct product of certain subcategories the so called blocks of the group Brauer s work then establishes correspondences between the blocks of the original group and blocks of certain subgroups the philosophy being that one is thereby reduced to a simpler situation In particular one can measure how nonsemisimple a category a block is by the size and structure of its so called defect group All these concepts are made explicit for the example of the special linear group of two by two matrices over a finite prime field Although the presentation is strongly biased towards the module theoretic point of view an attempt is made to strike a certain balance by also showing the reader the group theoretic approach In particular in the case of defect groups a detailed proof of the equivalence of the two approaches is given This book aims to familiarize students at the masters level with the basic results tools and techniques of a beautiful and important algebraic theory Some basic algebra together with the semisimple case are assumed to be known although all facts to be used are restated without proofs in the text Otherwise the book is entirely self contained **The Arcata Conference on Representations of Finite Groups, Part 1** Paul Fong,1987 The papers in these proceedings of the 1986 Arcata Summer Institute bear witness to the extraordinarily vital and intense research in the representation theory of finite groups The confluence of diverse mathematical disciplines has brought forth work of great scope and depth Particularly striking is the influence of algebraic geometry and cohomology theory in the modular representation theory and the character theory of reductive groups over finite fields and in the general modular representation theory of finite groups The continuing developments in block theory and the general character theory of finite groups is noteworthy The expository and research

aspects of the Summer Institute are well represented by these papers **Modern Trends in Algebra and Representation Theory** David Jordan,Nadia Mazza,Sibylle Schroll,2023-08-17 Expanding upon the material delivered during the LMS Autumn Algebra School 2020 this volume reflects the fruitful connections between different aspects of representation theory Each survey article addresses a specific subject from a modern angle beginning with an exploration of the representation theory of associative algebras followed by the coverage of important developments in Lie theory in the past two decades before the final sections introduce the reader to three strikingly different aspects of group theory Written at a level suitable for graduate students and researchers in related fields this book provides pure mathematicians with a springboard into the vast and growing literature in each area **Combinatorial Group Theory** Roger C. Lyndon,Paul E. Schupp,2015-03-12 From the reviews This book defines the boundaries of the subject now called combinatorial group theory it is a considerable achievement to have concentrated a survey of the subject into 339 pages This includes a substantial and useful bibliography over 1100 items the book is a valuable and welcome addition to the literature containing many results not previously available in a book It will undoubtedly become a standard reference Mathematical Reviews AMS 1979 *The Representation Theory of Finite Groups* W. Feit,1982-05-01 The Representation Theory of Finite Groups **Lectures on Profinite Topics in Group Theory** Benjamin Klopsch,Nikolay Nikolov,Christopher Voll,2011-02-10 In this book three authors introduce readers to strong approximation methods analytic pro p groups and zeta functions of groups Each chapter illustrates connections between infinite group theory number theory and Lie theory The first introduces the theory of compact p adic Lie groups The second explains how methods from linear algebraic groups can be utilised to study the finite images of linear groups The final chapter provides an overview of zeta functions associated to groups and rings Derived from an LMS EPSRC Short Course for graduate students this book provides a concise introduction to a very active research area and assumes less prior knowledge than existing monographs or original research articles Accessible to beginning graduate students in group theory it will also appeal to researchers interested in infinite group theory and its interface with Lie theory and number theory **Abstract Algebra** Celine Carstensen-Opitz,Benjamin Fine,Anja Moldenhauer,Gerhard Rosenberger,2019-09-02 A new approach to conveying abstract algebra the area that studies algebraic structures such as groups rings fields modules vector spaces and algebras that is essential to various scientific disciplines such as particle physics and cryptology It provides a well written account of the theoretical foundations and it also includes a chapter on cryptography End of chapter problems help readers with accessing the subjects *Computational Invariant Theory* Harm Derksen,Gregor Kemper,2015-12-23 This book is about the computational aspects of invariant theory Of central interest is the question how the invariant ring of a given group action can be calculated Algorithms for this purpose form the main pillars around which the book is built There are two introductory chapters one on Gr bner basis methods and one on the basic concepts of invariant theory which prepare the ground for the algorithms Then algorithms for computing invariants of

finite and reductive groups are discussed Particular emphasis lies on interrelations between structural properties of invariant rings and computational methods Finally the book contains a chapter on applications of invariant theory covering fields as disparate as graph theory coding theory dynamical systems and computer vision The book is intended for postgraduate students as well as researchers in geometry computer algebra and of course invariant theory The text is enriched with numerous explicit examples which illustrate the theory and should be of more than passing interest More than ten years after the first publication of the book the second edition now provides a major update and covers many recent developments in the field Among the roughly 100 added pages there are two appendices authored by Vladimi r Popov and an addendum by Norbert A Campo and Vladimir Popov   Algebraic Groups and Number Theory Vladimir Platonov,Andrei Rapinchuk,Rachel Rowen,1993-12-07 This milestone work on the arithmetic theory of linear algebraic groups is now available in English for the first time Algebraic Groups and Number Theory provides the first systematic exposition in mathematical literature of the junction of group theory algebraic geometry and number theory The exposition of the topic is built on a synthesis of methods from algebraic geometry number theory analysis and topology and the result is a systematic overview ofalmost all of the major results of the arithmetic theory of algebraic groups obtained to date   Finite Groups I Bertram Huppert,2025-05-05 Since its publication in 1967 Bertram Huppert s influential Endliche Gruppen I has remained a standard reference on group theory with its clear precise and complete exposition The present volume makes this classic text available in English for the first time updated with modern notation and notes In addition to foundational material the book contains the theory of permutation groups linear groups p groups nilpotent groups and solvable groups as well as the transfer homomorphism and ordinary representation theory All topics are fully developed and accessible to students with a basic knowledge of algebra Its comprehensive coverage and inclusion of more advanced topics make this self contained treatise an invaluable resource for graduate students and researchers   Representations Of Finite And Lie Groups Charles B Thomas,2004-10-08 This book provides an introduction to representations of both finite and compact groups The proofs of the basic results are given for the finite case but are so phrased as to hold without change for compact topological groups with an invariant integral replacing the sum over the group elements as an averaging tool Among the topics covered are the relation between representations and characters the construction of irreducible representations induced representations and Frobenius reciprocity Special emphasis is given to exterior powers with the symmetric group Sn as an illustrative example The book concludes with a chapter comparing the representations of the finite group SL2 p and the non compact Lie group SL2 P a

    A Guide to Quantum Groups Vyjayanthi Chari,Andrew N. Pressley,1995-07-27 Since they first arose in the 1970s and early 1980s quantum groups have proved to be of great interest to mathematicians and theoretical physicists The theory of quantum groups is now well established as a fascinating chapter of representation theory and has thrown new light on many different topics notably low dimensional topology and conformal field theory The goal of this book is to give a comprehensive

view of quantum groups and their applications The authors build on a self contained account of the foundations of the subject and go on to treat the more advanced aspects concisely and with detailed references to the literature Thus this book can serve both as an introduction for the newcomer and as a guide for the more experienced reader All who have an interest in the subject will welcome this unique treatment of quantum groups **Forty Years Of Algebraic Groups, Algebraic Geometry, And Representation Theory In China: In Memory Of The Centenary Year Of Xihua Cao's Birth** Jie Du,Jianpan Wang,Lei Lin,2022-10-21 Professor Xihua Cao 1920 2005 was a leading scholar at East China Normal University ECNU and a famous algebraist in China His contribution to the Chinese academic circle is particularly the formation of a world renowned ECNU School in algebra covering research areas include algebraic groups quantum groups algebraic geometry Lie algebra algebraic number theory representation theory and other hot fields In January 2020 in order to commemorate Professor Xihua Cao s centenary birthday East China Normal University held a three day academic conference Scholars at home and abroad gave dedications or delivered lectures in the conference This volume originates from the memorial conference collecting the dedications of scholars reminiscences of family members and 16 academic articles written based on the lectures in the conference covering a wide range of research hot topics in algebra The book shows not only scholars respect and memory for Professor Xihua Cao but also the research achievements of Chinese scholars at home and abroad **Whitaker's Books in Print** ,1998 **Kleinian Groups and Hyperbolic 3-Manifolds** Y. Komori,V. Markovic,C. Series,2003-11-10 The subject of Kleinian groups and hyperbolic 3 manifolds is currently undergoing explosively fast development with many old problems and conjectures close to resolution This volume proceedings of the Warwick workshop in September 2001 contains expositions of many of these breakthroughs including Minsky s lectures on the first half of the proof of the Ending Lamination Conjecture the Bers Density Conjecture by Brock and Bromberg the Tameness Conjecture by Kleineidam and Souto the state of the art in cone manifolds by Hodgson and Kerckhoff and the counter example to Thurston s K 2 conjecture by Epstein Marden and Markovic It also contains J rgensen s famous paper On pairs of once punctured tori in print for the first time The excellent collection of papers here will appeal to graduate students who will find much here to inspire them and established researchers who will find this valuable as a snapshot of current research **Kac-Moody Groups, their Flag Varieties and Representation Theory** Shrawan Kumar,2012-12-06 Kac Moody Lie algebras 9 were introduced in the mid 1960s independently by V Kac and R Moody generalizing the finite dimensional semisimple Lie alge bras which we refer to as the finite case The theory has undergone tremendous developments in various directions and connections with diverse areas abound including mathematical physics so much so that this theory has become a stan dard tool in mathematics A detailed treatment of the Lie algebra aspect of the theory can be found in V Kac s book Kac 90l This self contained work treats the algebro geometric and the topological aspects of Kac Moody theory from scratch The emphasis is on the study of the Kac Moody groups 9 and their flag varieties XY including their detailed

construction and their applications to the representation theory of $\mathfrak{g}$ In the finite case 9 is nothing but a semisimple Y simply connected algebraic group and X is the flag variety 9 Py for a parabolic subgroup $\mathfrak{p} \subset \mathfrak{g}$

The book delves into Sl2 Representations Of Finitely Presented Groups. Sl2 Representations Of Finitely Presented Groups is an essential topic that needs to be grasped by everyone, ranging from students and scholars to the general public. This book will furnish comprehensive and in-depth insights into Sl2 Representations Of Finitely Presented Groups, encompassing both the fundamentals and more intricate discussions.

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