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### CHARACTER VARIETY OF REPRESENTATIONS OF A FINITELY GENERATED GROUP IN $SL_2$

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This is a partial exposition of [S4, S5, S6], which study the space of representations of a (finitely generated) group Γ in SL<sub>2</sub> and GL<sub>2</sub> in an attempt of its application in geometry: Teichmüller spaces, knot theory, hyperbolic manifolds, moduli spaces, · · · , 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], · · · , etc). For simplicity, we omit the case for GL<sub>2</sub> in the present exposition. Let us explain the main result of the present paper.

Let  $\Gamma$  be a group. The purpose of the present paper is to introduce the character variety  $Ch(\Gamma, SL_2)$  in order to parameterize conjugacy classes of representations of  $\Gamma$ 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 scaler 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  $\operatorname{Hom}(\Gamma,\operatorname{SL}_n)$  be the functor  $R \in \{\operatorname{commutative rings with } 1\} \mapsto \operatorname{Hom}(\Gamma,\operatorname{SL}_n(R)) \in \{\operatorname{sets}\}$ . The functor is representable (see §1.3 Lemma) and so, for an abuse of notation, we denote by the same  $\operatorname{Hom}(\Gamma,\operatorname{SL}_n)$  the scheme over  $\mathbb Z$  representing the functor. The group scheme  $\operatorname{PGL}_n$  acts on  $\operatorname{Hom}(\Gamma,\operatorname{SL}_n)$ . Whether the universal categorical quotient  $\operatorname{Hom}(\Gamma,\operatorname{SL}_n)//\operatorname{PGL}_n$  (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  $\operatorname{Ch}(\Gamma,\operatorname{SL}_2)$  together with its discriminant subvariety  $D_\Gamma$  as schemes over  $\mathbb Z$  abstractly, and ii) the  $\operatorname{PGL}_2$ -invariant morphism  $\pi_\Gamma$ :  $\operatorname{Hom}(\Gamma,\operatorname{SL}_2) \to \operatorname{Ch}(\Gamma,\operatorname{SL}_2)$ , for which we prove that i) the restriction of  $\pi_\Gamma$  on the complement of  $\pi_\Gamma^{-1}(D_\Gamma)$  is a principal  $\operatorname{PGL}_2$ -bundle with respect to the etal topology, and ii) the inverse image  $\pi_\Gamma^{-1}(D_\Gamma)$  is a subfunctor of  $\operatorname{Hom}(\Gamma,\operatorname{SL}_2)$  consisting of abelian or reducible representations. This implies that the complement  $\operatorname{Hom}^*(\Gamma,\operatorname{SL}_2) := \operatorname{Hom}(\Gamma,\operatorname{SL}_2) \setminus \pi^{-1}(D_\Gamma)$  consists of absolutely irreducible representations, and that  $\operatorname{Hom}^*(\Gamma,\operatorname{SL}_2)$  has the universal categorical quotient space  $\operatorname{Ch}^*(\Gamma,\operatorname{SL}_2) := \operatorname{Ch}(\Gamma,\operatorname{SL}_2) \setminus D_\Gamma$  defined over  $\mathbb Z$ . Then the result is specialized

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#### **Table of Contents Sl2 Representations Of Finitely Presented Groups**

- 1. Understanding the eBook Sl2 Representations Of Finitely Presented Groups
  - The Rise of Digital Reading Sl2 Representations Of Finitely Presented Groups
  - Advantages of eBooks Over Traditional Books
- 2. Identifying Sl2 Representations Of Finitely Presented Groups
  - Exploring Different Genres
  - o Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
- 3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Sl2 Representations Of Finitely Presented Groups
  - User-Friendly Interface
- 4. Exploring eBook Recommendations from Sl2 Representations Of Finitely Presented Groups
  - Personalized Recommendations
  - Sl2 Representations Of Finitely Presented Groups User Reviews and Ratings
  - Sl2 Representations Of Finitely Presented Groups and Bestseller Lists
- 5. Accessing Sl2 Representations Of Finitely Presented Groups Free and Paid eBooks
  - Sl2 Representations Of Finitely Presented Groups Public Domain eBooks
  - Sl2 Representations Of Finitely Presented Groups eBook Subscription Services
  - Sl2 Representations Of Finitely Presented Groups Budget-Friendly Options

- 6. Navigating Sl2 Representations Of Finitely Presented Groups eBook Formats
  - o ePub, PDF, MOBI, and More
  - Sl2 Representations Of Finitely Presented Groups Compatibility with Devices
  - Sl2 Representations Of Finitely Presented Groups Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Sl2 Representations Of Finitely Presented Groups
  - Highlighting and Note-Taking Sl2 Representations Of Finitely Presented Groups
  - Interactive Elements Sl2 Representations Of Finitely Presented Groups
- 8. Staying Engaged with Sl2 Representations Of Finitely Presented Groups
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Sl2 Representations Of Finitely Presented Groups
- 9. Balancing eBooks and Physical Books Sl2 Representations Of Finitely Presented Groups
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Sl2 Representations Of Finitely Presented Groups
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Sl2 Representations Of Finitely Presented Groups
  - Setting Reading Goals Sl2 Representations Of Finitely Presented Groups
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Sl2 Representations Of Finitely Presented Groups
  - Fact-Checking eBook Content of Sl2 Representations Of Finitely Presented Groups
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements

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