

THE SIXTH MOMENT OF AUTOMORPHIC L -FUNCTIONS

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Abstract

We investigate the sixth moment of the family of L -functions associated to holomorphic modular forms on GL_2 with respect to a congruence subgroup $\Gamma_1(q)$. We improve on previous work and obtain an unconditional upper bound of the correct order of magnitude.

1. INTRODUCTION

Moments of L -functions are among the central objects of study in modern analytic number theory, and there is a vast literature on the subject. In this paper, we shall be concerned with a family of L -functions attached to automorphic forms on GL_2 . Specifically, we consider the sixth moment of L -functions associated to the family of holomorphic modular forms with respect to the congruence subgroup $\Gamma_1(q)$ (see [6] for definitions). Our work is motivated by the work of Djanković [3] and Chandee and Li [2] on this family. For a detailed introduction to this family of L -functions, see the introductions of the above two papers.

Let $S_k(\Gamma_1(q))$ denote the space of holomorphic cusp forms on $\Gamma_1(q)$. We assume $k \geq 3$ is an odd integer and q is prime (these assumptions are made mostly to eliminate oldforms). Then $S_k(\Gamma_1(q))$ is a Hilbert space with the Petersson's inner product

$$\langle f, g \rangle = \int_{\Gamma_1(q) \backslash \mathbb{H}} f(z) \overline{g(z)} y^{k-2} dx dy,$$

and

$$S_k(\Gamma_1(q)) = \bigoplus_{\chi \pmod{q}} S_k(\Gamma_0(q), \chi).$$

Let \mathcal{H}_χ be an orthogonal basis for $S_k(\Gamma_0(q), \chi)$ consisting of Hecke cusp forms, normalized so that the first Fourier coefficient is 1. For each $f \in \mathcal{H}_\chi$, we let $L(f, s)$ be the L -function associated to f , defined for $\operatorname{Re} s > 1$ as

$$L(f, s) = \sum_{n \geq 1} \frac{\lambda_f(n)}{n^s} = \prod_p \left(1 - \frac{\lambda_f(p)}{p^s} + \frac{\chi(p)}{p^{2s}} \right)^{-1},$$

where $\{\lambda_f(n)\}$ are the Hecke eigenvalues of f . In general, these satisfy the Hecke relation

$$\lambda_f(m)\lambda_f(n) = \sum_{d|(m,n)} \chi(d)\lambda_f\left(\frac{mn}{d^2}\right). \quad (1.1)$$

We define the completed L -function as

$$\Lambda\left(f, \frac{1}{2} + s\right) = \left(\frac{q}{4\pi^2}\right)^{\frac{s}{2}} \Gamma\left(s + \frac{k}{2}\right) L\left(f, \frac{1}{2} + s\right), \quad (1.2)$$

which satisfies the functional equation

$$\Lambda\left(f, \frac{1}{2} + s\right) = i^k \overline{\eta_f} \Lambda\left(\overline{f}, \frac{1}{2} - s\right)$$

Automorphic Functions

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Table of Contents Automorphic Functions

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

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

- Interactive and Gamified eBooks

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