Dissertation Defense

Topics in the analytic theory of L-functions and harmonic Maass forms.

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Abstract: This thesis presents several new results in the theory of $L-functions$, modular forms, and harmonic Maass forms. We prove a general congruence result for mixed weight modular forms using facts about direct products of Galois representations. As an application we prove explicit congruences for the conjugacy growth series of wreath products of finite groups and finitary permutations groups. We continue studying the $p-adic$ properties of modular forms and begin to answer a question of Mazur's about the existence of an eigencurve for harmonic Maass forms by constructing two infinite familes of harmonic Maass Hecke eigenforms, and then assemble these forms to produce $p-adic$ Hecke eigenlines. We also study the hyperbolicity of doubly infinite families of polynomials related to the partition function and general L-functions. As a result we prove when the partition function satisfies the higher Turan inequalities and provide evidence for the Generalized Riemann Hypothesis for suitable L-functions. We also show that these L-functions satisfy the Gaussian Unitary Ensemble random matrix model in derivative aspect. Finally, we study the recent connection between sphere packing and energy optimization and modular forms. We construct a number of infinite families of Schwartz functions using modular forms, which are eigenfunctions of the Fourier transform.

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Mathematics
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