

Explicit Approaches to Elliptic Curves and Modular Abelian Varieties

Intellectual Merit: The projects in this proposal would generalize the highly influential tables of Cremona to the next (ordered by discriminant) totally real number field and to higher dimensional modular abelian varieties. This would improve on algorithms available for computing with elliptic curves and abelian varieties, and provide useful data and tools for number theory researchers. The proposed research would also advance techniques for constructing points and cohomology classes on elliptic curves, and for understanding the arithmetic of elliptic curves over number fields. This project would have as a concrete deliverable new publicly available tables and software that will be of use to many number theorists.

Broader Impact: The PI is co-authoring a popular expository book with Barry Mazur on the Riemann Hypothesis, co-authoring a graduate level book with Kenneth Ribet on modular forms and Hecke operators, and intends to release a new edition of his modular forms book. The PI has tables of data that are freely available online, and whose creation has been supported by NSF FRG grant DMS-0757627, and the proposed research would expand these tables further. He will also continue to organize the development of the free open source NSF-funded Sage mathematical software project that he started. The PI organizes dozens of “Sage Days” workshops that involve many undergraduate and graduate students, and touch on number theory, algebraic topology, combinatorics, special functions, numerical computation, and other areas. The PI is also a co-PI on the UTMOST NSF grant (DUE-1020378), whose goal is to make Sage more accessible to high school and college teachers and students.