William A. Stein

October 27, 1999

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EDUCATION

- **University of California at Berkeley**
  Ph.D., mathematics, expected May 2000.
  Explicit approaches to modular abelian varieties
- **Northern Arizona University**, Flagstaff.
  M.S. student, mathematics, 1994–1995.
  B.S., mathematics, 1994.

AWARDS

- Cal@SiliconValley university fellowship, 1999–2000.
- Sarah M. Hallam department fellowship, Spring 1999.
- Vice Chancellor research grant (computing equipment), 1999.
- Graduate student researcher, Fall 1998.
- Outstanding mathematics senior, 1994.
- Applied math modeling contest, meritorious ranking, 1994.

IN PROGRESS

- *Lectures on Serre's conjectures*, with K. A. Ribet, to appear in the IAS/Park City Mathematics Institute Lecture Series.
- *Mod* 5 *approaches to modularity of icosahedral Galois representations*, with K. M. Buzzard.
- *Explicit approaches to modular abelian varieties*, UC Berkeley Ph.D. thesis under H. W. Lenstra.
- *Hecke: The modular forms calculator*, computer software.
- *The modular forms database:*
  http://shimura.math.berkeley.edu/~was/Tables
- *Component groups of optimal quotients of Jacobians.*
- *Visibility of Shafarevich-Tate groups of modular abelian varieties*, with A. Agashé.
- *Computing analytic invariants of modular eigenforms*, with H. Verrill.
- *Lectures on modular forms and Galois representations*, with K. A. Ribet, intended for Springer-Verlag's Universitext series.

PUBLICATIONS

- *Empirical evidence for the Birch and Swinnerton-Dyer conjectures for modular Jacobians of genus 2 curves*, with E. V. Flynn, F. Leprévost, E. F. Schaefer, M. Stoll, J. L. Wetherell, submitted.
- *Parity structures and generating functions from Boolean rings*, with D. P. Moulton, submitted.
- *Fallacies, Flaws, and Flimflam #92: An Inductive Fallacy*, with A. Riskin, College Math. Journal 26:5 (1995), 382.

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TEACHING

NSF Sponsored IAS/Park City Mathematics Institute

- *Teaching Assistant*, Summer 1999. Led problem sessions and prepared notes for Ken Ribet's course on Serre's conjectures for advanced number theory graduate students.

University of California at Berkeley

- *Curriculum Development*, Fall 1997–Summer 1998. Developed curriculum materials and MATLAB software for workshop based calculus and linear algebra courses at UC Berkeley.
- *Instructor*, Summer 1997. Taught discrete mathematics to a class of 20–30 undergraduates. Duties included preparing and delivering lectures, writing and grading exams, and conducting office hours.
- *Teaching Assistant*, Fall 1995–Spring 1997. Led discussion sections for the full range of undergraduate linear algebra and calculus courses.
- **Evaluation average: 5.8 out of 7 from 300 students.**

Northern Arizona University

- *Teaching*, 1994–1995. Taught two semesters of college algebra and other freshman topics to a class of 30–40 undergraduates. Duties included all aspects of organizing a course, including preparing and delivering lectures and grading examinations.

LECTURES

- Delivered over twenty talks and organized graduate student seminars on modular forms and abelian varieties at UC Berkeley.
- *Participant in panel discussion on the use of technology in the classroom*, Park City Math. Inst., July, 1999.
- *Demonstrations of number theory software*, Park City Math. Inst., July, 1999.
- *Shafarevich-Tate groups of modular abelian varieties*, Park City Math. Inst., June, 1999.
- *Shafarevich-Tate groups of modular abelian varieties*, Advances in Number Theory, Leiden, Netherlands, April, 1999.
- *Visibility of Shafarevich-Tate groups*, Arizona Winter School, 1999.

COMPUTING

Extensive experience with `C++`, UNIX, MAGMA, and PARI.

ADDRESS

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PERSONAL

US Citizen, born February, 1974.

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REFERENCES

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ABSTRACTS

- *Lectures on Serre's conjectures (77 pages):* This is an expository paper based on Ken Ribet's lectures at the 1999 Park City Mathematics Institute; it will be published in the conference proceedings.
- *Mod* 5 *approaches to modularity of icosahedral Galois representations (16 pages):* Consider a continuous odd irreducible representation $\rho : \mathrm{Gal}(\overline{\mathbf{Q}}/\mathbf{Q}) \to \mathrm{GL}_2(\mathbf{C})$. A special case of a general conjecture of Artin is that the L-function $L(\rho, s)$ associated to ρ is entire. Buzzard and I give new examples of representations ρ that satisfies this conjecture. These were obtained by applying a recent theorem of Buzzard and Taylor to a mod 5 reduction of ρ, combined with a computational verification of modularity of a related mod 5 representation.
- *Explicit approaches to modular abelian varieties (130 pages):* I give algorithms for computing on modular abelian varieties of any dimension. More precisely, I describe how to compute congruences, the modular degree, the rational part of the special value of the L-function and of its twists, the component group at primes of multiplicative reduction, the period lattice, and the real and imaginary volumes. There are still many invariants that I have not been able to compute in all cases, including the exact structure of the torsion subgroup and the regulator. The second part of my thesis contains investigations into several open problems, including the Birch and Swinnerton-Dyer conjecture, Artin's conjecture on complex Galois representations, and Serre's conjecture.
- *Hecke: The modular forms calculator:* Hecke is a `C++` package for computing with spaces of modular forms and modular abelian varieties. I have been invited to visit the MAGMA group in Sydney in order to make Hecke a part of their computer algebra system, and I have already ported my code to MAGMA.
- *The modular forms database:* This is a collection of modular eigenforms, special values of L-functions, arithmetic invariants of modular abelian varieties, and other data. These tables, which are freely available on the Internet, have already been used by many people.
- *Component groups of optimal quotients of Jacobians (16 pages):* Let A be an optimal quotient of $J_0(N)$. The main theorem of this paper gives a relationship between the modular degree of A and the order of the component group of A. From this I deduce a computable for-

mula for the component group of any optimal quotient of $J_0(N)$ at a prime of multiplicative reduction. I then compute over one thousand examples leading me to conjecture that the torsion and component groups of quotients of $J_0(p)$ are as simple as possible.

- *Visibility of Shafarevich-Tate groups of modular abelian varieties (20 pages):* We study Mazur's notion of visibility of Shafarevich-Tate of modular abelian varieties, and use it to verify the conjecture of Birch and Swinnerton-Dyer for several specific abelian varieties.
- *Lectures on modular forms and Galois representations (170 pages):* In 1996, Ken Ribet taught an advanced course on modular forms and Galois representations. In collaboration with Ribet, I am turning my course notes into a book that is intended for publication in Springer-Verlag's Universitext series.
- *Empirical evidence for the Birch and Swinnerton-Dyer conjecture for modular Jacobians of genus 2 curves (22 pages):* We provide systematic numerical evidence for the BSD conjecture in the case of dimension two. This conjecture relates six quantities associated to a Jacobian over the rational numbers. One of these quantities is the size S of the Shafarevich-Tate group. Unable to compute S directly, we compute the five other quantities and solve for the conjectural value $S_?$ of S. For all 32 curves considered, the real number $S_?$ is very close to either 1, 2, or 4, and agrees with the size of the 2-torsion of the Shafarevich-Tate group, which we could compute.
- *Parity structures and generating functions from Boolean rings (8 pages):* Let S be a finite set and T be a subset of the power set of S. Call T a *parity structure* for S if, for each subset b of S of odd size, the number of subsets of b that lie in T is even. We classify parity structures using generating functions from a free boolean ring. We also show that if T is a parity structure, then, for each subset b of S of even size, the number of subsets of b of odd size that lie in T is even. We then give several other properties of parity structures and discuss a generalization.