TITLE AND ABSTRACTS FOR THE 2012 ATKIN WORKSHOP

1. Jennifer Balakrishnan, *p-adic heights on elliptic curves.*

Abstract: In 2006, the work of Mazur-Stein-Tate gave an effective algorithm to compute p-adic heights on elliptic curves over $\mathbb{Q}$. We begin with a brief overview of their algorithm and discuss a generalization to number fields. This is joint work with Mirela Ciperiani and William Stein.

2. Jonathan Bober, *Searching for [equations of] elliptic curves over* $\mathbb{Q}(\sqrt{5})$.

Abstract: In making complete tables of elliptic curves over $\mathbb{Q}(\sqrt{5})$, we need a way to make a list of equations of curves from a list of Hilbert modular forms. There seems to be no known efficient algorithm for solving this problem in all cases, but there are many strategies which will work well sometimes. I will describe the variety of techniques that were used to make a list of the first (ordered by conductor norm) 1414 isogeny classes of curves over $\mathbb{Q}(\sqrt{5})$.

This is joint work with Alyson Deines, Ariah Klages-Mundt, Benjamin LeVeque, R. Andrew Ohana, Ashwath Rabindranath, Paul Sharaba, and William Stein.

3. John Cremona, *Elusive isogenies and unusual modular curves.*

Abstract: In a recent paper, Sutherland asked the question, to what extent is the existence of a rational ℓ-isogeny for a given elliptic curve E defined over a number field K a "local" phenomenon, in the sense that E possesses such an isogeny if and only if the reduction of E modulo p does for almost all primes p of K. Sutherland establishes a criterion for this, which over $\mathbb{Q}$ is satisfied for all ℓ and all elliptic curves, with the single exception of $\ell = 7$ and curves E with j-invariant $2268945/128$, but which relies on the ground field not containing the quadratic subfield of the ℓth cyclotomic field. We give an infinite set

of counterexamples for $\ell = 5$ over $\mathbb{Q}(\sqrt{5})$, parametrised by a genus 0 modular curve of level 5, which is a moduli space for elliptic curves whose projective mod 5 representation has image isomorphic to V_4. We will also report on progress towards finding similar examples with $\ell = 13$ associated to a modular curve of genus 3 and level 13, via the closely related problem (which may be of independent interest) of finding explicit models for modular curves parametrising elliptic curves whose projective mod ℓ representation has image isomorphic to A_4 or A_5. This is joint work with Barinder Banwait.

4. Lassina Dembele, *Galois representations and equations of hyperelliptic curves.*

Abstract: This is a progress report. We will present an algorithm which, given a Hilbert newform f of parallel weight 2 such that the field of Fourier coefficients K_f is at most quadratic and the associated mod 2 residual Galois representation is surjective, finds the corresponding hyperelliptic curve whose Jacobian has RM by K_f. This construction assumes the Eichler-Shimura conjecture.

5. Noam Elkies, *Remarks on isogenies over* $\mathbb{Q}(\sqrt{5})$ *and other number fields.*

Abstract: On the occasion of the creation of a table of modular elliptic curves over $\mathbb{Q}(\sqrt{5})$, we review the "Remarks on isogenies" that accompanied the "Antwerp" tables (LNM 476), and outline some of the new phenomena and open questions that arise in attempting to give a similar overview of isogenies defined over $\mathbb{Q}(\sqrt{5})$ or other number fields. In particular, we account for some new isogeny degrees and graphs not seen over $\mathbb{Q}$, and explain why the problem of proving completeness of the list over $\mathbb{Q}(sqrt5)$ is difficult but not hopeless.

6. Edray Goins, *There Exist an Elliptic Curve* $E/\mathbb{Q}$ *with Mordell-Weil Group* $Z_2 \times Z_8 \times \mathbb{Z}^4$*?*

Abstract: An elliptic curve E defined over the rational numbers $\mathbb{Q}$ is an arithmetic-algebraic object: It is simultaneously a nonsingular projective curve with an affine equation $Y^2 = X^3 + A\,X + B$, which

allows one to perform arithmetic on its points; and a finitely generated abelian group $E(\mathbb{Q}) \simeq E(\mathbb{Q})_{\text{tors}} \times \mathbb{Z}^r$, which allows one to apply results from abstract algebra. The abstract nature of its rank r can be made explicit by searching for rational points (X, Y).

The largest possible subgroup of an elliptic curve E is $E(\mathbb{Q})_{\text{tors}} \simeq Z_2 \times Z_8$, and, curiously, these curves seem to have the least known information about the rank r. To date, there are twenty-seven known examples of elliptic curves over $\mathbb{Q}$ having Mordell-Weil group $E(\mathbb{Q}) \simeq Z_2 \times Z_8 \times \mathbb{Z}^3$, yet no larger rank has been found.

In this talk, we give some history on the problem of determining properties of r, explain its importance by discussing the conjecture of Birch and Swinnerton-Dyer, and analyze various approaches to finding curves of large rank.

7. Matthew Greenberg, *Definite quaternion algebras and triple product p-adic L-functions.*

Abstract: Formulas of Gross–Kudla, Boecherer–Schulze-Pillot, and Ichino express central values of triple product L-functions in terms of trilinear forms evaluated on specific test vectors. I will discuss joint work with Marco Seveso in which we show that, in the "definite case," these trilinear forms can be p-adically interpolated, giving rise to triple product p-adic L-functions.

8. Richard Pinch, *Elliptic curves with good reduction away from 2.*

Abstract: We show how to determine the complete list of elliptic curves over $\mathbb{Q}(\sqrt{5})$ with good reduction away from the prime 2. The computation makes use of Baker's method and techniques for verifying that a list of solutions to a Diophantine equation is complete.

9. Kenneth Ribet, *TBA.*

10. William Stein, *A Database of Elliptic Curves over* $\mathbf{Q}(\sqrt{5})$*—First Report.*

Abstract: I will describe a tabulation of (conjecturally) modular elliptic

curves over the field $\mathbf{Q}(\sqrt{5})$ up to the first curve of rank 2. Using an efficient implementation of an algorithm of Lassina Dembele, we computed tables of Hilbert modular forms of weight $(2,2)$ over $\mathbf{Q}(\sqrt{5})$, and via a variety of methods we constructed corresponding elliptic curves, including (again, conjecturally) all elliptic curves over $\mathbf{Q}(\sqrt{5})$ that have conductor with norm less than or equal to 1831.

11. Nike Vatsal, *Some number theory associated to modular forms on $SL(2)$.*

Abstract: We'll discuss some more or less well-known results on automorphic forms on $SL(2)$, and give some arithmetic consequences (which may be less well-known). The main idea is to explain how some familiar questions from number theory maybe very naturally formulated in terms of automorphic forms on $SL(2)$, rather than the usual group $GL(2)$

12. John Voight, *Computing power series expansions of modular forms.*

Abstract: We exhibit an method to numerically compute power series expansions of modular forms on a cocompact Fuchsian group using the explicit computation a fundamental domain and linear algebra.