Curriculum Vitae

Abhinav Kumar

October 2013

Department of Mathematics,
Massachusetts Institute of Technology,
77 Massachusetts Avenue
Cambridge, MA 02139.

Phone (office): 617-253-4057
Email: abhinav@math.mit.edu
Webpage: http://web.mit.edu/abhinavk/www/

Education

2002 - 2006 Ph.D. in Mathematics, Harvard University, supervised by Barry Mazur and Noam Elkies.

1998 - 2002 S.B. in Mathematics, Physics, and Computer Science, Massachusetts Institute of Technology.

Employment

- Associate professor, Massachusetts Institute of Technology, July 2012 - present.
- Assistant professor, Massachusetts Institute of Technology, July 2007 - June 2012.
- Postdoctoral researcher, Microsoft Research theory group, June 2006 - June 2007.

Grants and Fellowships

- Solomon Buchsbaum Research grant, MIT, 2013 - .
- MIT India Innovation Fund grant, December 2012 - August 2014.
- NSF CAREER Grant, March 2010 - Feb 2015 (DMS-0952486).
- NSF Research Grant, 2008-2011 (DMS-0757765).
- Solomon Buchsbaum Research grant, MIT, 2007 - 2013.
- Clay Liftoff Fellowship, Clay Math Institute, 2006.
- Harvard Graduate School of Arts and Sciences Merit Fellowship, Harvard University, 2005-2006.
- William Lowell Putnam Fellowship, Harvard University, 2002-2006.

Publications and Preprints

- *Examples of abelian surfaces with everywhere good reduction*, with L. Dembélé.,
  27 pages, submitted, arXiv:1309.3821.
- *Simplices and optimal codes in projective spaces*, with H. Cohn and G. Minton.,
  50 pages, submitted, arXiv:1308.3188.
- *K3 surfaces and equations for Hilbert modular surfaces*, with N. D. Elkies,
  82 pages, to appear in Algebra Number theory, arXiv:1209.3527.
- *Formal duality and generalizations of the Poisson summation formula*, with H. Cohn, C. Reiher
  and A. Schürmann, 17 pages, to appear in Contemp. Math., arXiv:1306.6796.

- *Metacommutation of Hurwitz primes*, with H. Cohn,
  11 pages, to appear in Proc. Amer. Math. Soc., 1307.0443.
- *Multiplicative excellent families of elliptic surfaces of type* E_7 *or* E_8, with T. Shioda,
  Algebra Number Theory 7 (2013) , no. 7, 1613–1641, arXiv:1105.1715.
- *Elliptic fibrations on a generic Jacobian Kummer surface*,
  45 pages, to appear in J. Algebraic. Geom., arXiv:1105.1715.
- *Using elimination theory to construct rigid matrices*, with S. V. Lokam, V. M. Patankar and J. Sarma M. N.,
  to appear in Comput. Complexity, online first DOI: 10.1007/s00037-013-0061-0,
  arXiv:0910.5301.
- *Rigidity of spherical codes*, with H. Cohn, Y. Jiao and S. Torquato,
  Geom. Topol. 15 (2011), no. 4, 2235–2273, arXiv:1102.5060.
- *Point configurations that are asymmetric yet balanced*, with H. Cohn, N. D. Elkies and A. Schürmann,
  Proc. Amer. Math. Soc. 138 (2010), no. 8, 2863–2872, arXiv:0812.2579.
- *Ground states and formal duality relations in the Gaussian core model*, with H. Cohn and A. Schürmann,
  Physical Review E 80 (2009), 061116, arXiv:0911.2169.
- *Algorithmic design of self-assembling structures*, with H. Cohn,
  Proc. Nat. Acad. Sci. 106 (2009) no. 24, 9570–9575, arXiv:0906.3550.
- *Optimality and uniqueness of the Leech lattice among lattices*, with H. Cohn,
  Ann. of Math. 170 (2009), No. 3, 1003–1050. arXiv:math.MG/0403263.
- *Counterintuitive ground states in soft-core models*, with H. Cohn,
  Physical Review E 78 (2008), 061113, arXiv:0811.1236.
- *K3 surfaces associated with curves of genus two*,
  Internat. Math. Res. Notices 2008, no. 6, Art. ID rnm165, 26 pp., arXiv:math.AG/0701669.
- *Uniqueness of the* $(22, 891, 1/4)$ *spherical code*, with H. Cohn,
  New York J. Math. 13 (2007), 147–157, arXiv:math.MG/0607448.
- *Universally optimal distribution of points on spheres*, with H. Cohn,
  J. Amer. Math. Soc. 20 (2007), no. 1, 99–148.
- *The* D_4 *root system is not universally optimal*, with H. Cohn, J. H. Conway and N. D. Elkies,
  Experiment. Math. 16 (2007), 313–320, arXiv:math.MG/0607447.
- *The densest lattice in twenty-four dimensions*, with H. Cohn,
  Electron. Res. Announc. Amer. Math. Soc. 10 (2004), 58–67, arXiv:math.MG/0408174.
- *A proof of Pieri's formula using generalized Schensted insertion algorithm for RC-graphs*, with M. Kogan,
  Proc. Amer. Math. Soc. 130 (2002), 2525-2534, arXiv:math.CO/0010109.

Papers in preparation

- *Algebraic models for Teichmüller curves in Hilbert modular surfaces*, with R. Mukamel.
- *Orbit parametrizations for K3 surfaces*, with M. Bhargava and W. Ho.

Students

- Tathagata Sengupta, Ph.D. August 2011. Thesis topic: "Supersingular K3 surfaces"
- Gregory Minton, Ph.D. September 2013. Thesis topic: "Computer-Assisted Proofs in Geometry and Physics"
- Ruthi Hortsch, Ph.D. expected 2016.
- UROP (undergraduate research) students: Benjamin Filippenko, Maja Rudolph, Daniel Fremont,
  Eben Freeman, Kyle Miller, Fan Wei, David Rush, Siyao Xu, Qinxuan Pan, Hansheng Diao.

Other Awards and Honors

- Jon A. Bucsela Prize for top undergraduate student in Mathematics, MIT, 2002.
- Joel Matthew Orloff Award for outstanding scholarship in physics, MIT, 2002.
- Member of Phi Beta Kappa, Sigma Xi and Tau Beta Pi honor societies (2002-present).
- William Lowell Putnam Undergraduate Mathematics Competition: 18th place in 1998, Putnam Fellow in 1999 and 2000, 16th place in 2001.
- Boston Area Undergraduate Physics contest: 2nd place in 1999, 3rd place in 2000, 4th place in 2001.
- International Math Olympiad: Silver medal in 1997, Gold medal in 1998.
- Indian Institute of Technology Joint entrance examination, 1998: first place, out of approximately 125,000 candidates.
- Indian National Talent Search scholar, 1996.

Professional Activities and Service

- Member of editorial board of Contributions to Discrete Mathematics, 2011-present.
- Refereed articles for International Math Research Notices, Journal of Combinatorial Theory A, SIAM Journal of Discrete Math, American Math Monthly, Journal of Mathematical Physics, Duke Math Journal, Proceedings of the AMS, LMS Journal of Computation and Mathematics, Electronic Journal of Combinatorics, Transactions of the AMS, Physical Review E.
- Member of MIT graduate admissions committee, 2011 and 2012.
- Thesis committee member and reader for Chris Davis (2009), Ronen Mukamel (2011), Jennifer Balakrishnan (2011), Catherine Lennon (2011).
- Reviewed grant proposals for NSA and NSF, served on NSF panel.
- Member of the American Mathematical Society.

Teaching

- Commutative Algebra, MIT, Fall 2013.
- Mathematical Problem Solving, MIT, Fall 2010 - 2013.
- Seminar in Number Theory, MIT, Spring 2013.
- Algebraic Number Theory, MIT, Spring 2013.
- Differential Equations (recitation), MIT, Fall 2012.
- Theory of Numbers, MIT, Spring 2012.
- Multivariable Calculus (recitation), MIT, Fall 2011.
- Theory of Numbers, MIT, Spring 2011.
- Differential Equations, MIT, Fall 2010.
- Algebraic Number Theory, MIT, Spring 2010.
- Algebraic Geometry I, MIT, Fall 2008.
- Seminar in Number Theory, MIT, Fall 2008.
- Topics in Algebraic Geometry, MIT, Spring 2008.
- Real Analysis, MIT, Fall 2007.
- Seminar on Sphere Packing, Harvard University, Spring 2006.
- Linear Algebra and Differential Equations, Harvard University, Spring 2005.

Talks

- *K3 surfaces and arithmetic questions*, AIM workshop on Algebraic modular forms, 2013.
- *Equations for Hilbert modular surfaces*, Emory University Algebra and Number Theory seminar, 2013.
- *Existence of tight simplices and other codes in compact spaces*, AMS Eastern Sectional Meeting, Special Session on Discrete Geometry of Polytopes, 2013.
- *Real multiplication abelian surfaces with everywhere good reduction*, New York Joint Number theory seminar, 2013.
- *Multiplicative excellent families of elliptic surfaces of type* E_7 *or* E_8, New Trends in Arithmetic and Geometry of Algebraic Surfaces, CIRM Marseilles, 2013.
- *Moduli spaces of elliptic K3 surfaces*, Brown University Algebra seminar, 2013.
- *Real multiplication abelian surfaces with everywhere good reduction*, BC-MIT Number Theory seminar, 2013.
- *Periodic packings, potential energy and formal duality*, UCLA Combinatorics seminar, 2013.
- *Metacommutation of Hurwitz primes*, Joint Math Meetings (San Diego), Special session on Arithmetic theory of quadratic forms and lattices, 2013.
- *Formally dual configurations in Euclidean space and in abelian groups*, Joint Math Meetings (San Diego), Special session on Discrete Geometry and Algebraic Combinatorics, 2013.
- *Lattices, sphere packings and spherical codes: geometric optimization problems*, Cornell University Number Theory seminar, 2012.
- *Abelian surfaces with everywhere good reduction*, Northwestern University Number Theory seminar, 2012.
- *Abelian surfaces with everywhere good reduction*, Harvard University Number Theory seminar, 2012.
- *On some kissing configurations in low dimensions*, Mathematisches Forschungsinstitut Oberwolfach: Workshop on optimal and near optimal configurations on lattices and other manifolds, 2012.
- *Inverse problems in potential energy minimization*, Shanghai conference on Algebraic Combinatorics, 2012.
- *Multiplicative excellent families of elliptic surfaces of type* E_7 *or* E_8 , Rikkyo university, 2012.
- *Rational elliptic surfaces with high Mordell-Weil rank and multiplicative bad fibers* , MIT number theory seminar, 2012.
- *Matrix rigidity and elimination theory*, workshop on Questions in geometry arising in the sciences, Texas A&M, 2012.
- *Rational elliptic surfaces with high Mordell-Weil rank and multiplicative bad fibers*, Texas Algebraic Geometry Symposium, 2012.
- *Rigidity of spherical codes, and kissing numbers*, Fourth conference in Discrete Geometry and Algebraic Combinatorics, Brownsville, 2012.
- *Rational elliptic surfaces with Mordell-Weil lattice* E_8 *and multiplicative reduction*, Joint Math Meetings (Boston), Special session on Rational Points on Varieties, 2012.
- *K3 surfaces, orbit parametrizations and generalizations of Rubik's cube*, Arithmetic invariant theory seminar, Princeton, 2011.
- *Energy minimization for lattices and periodic configurations, and formal duality*, Banff workshop on diophantine methods, lattices and arithmetic theory of quadratic forms, 2011.
- Northeastern University research seminar in mathematics, 2011.
  1. *Linear programming bounds in geometry and coding theory*
  2. *Potential energy minimization and universal optimality*.
- *Rigidity of spherical codes, and kissing numbers in high dimensions*, Fields Institute workshop on Rigidity and Symmetry, 2011.
- *Elliptic fibrations on a generic Jacobian Kummer surface*, Wesleyan University Algebra Seminar, 2011.
- *Equations for abelian surfaces with real multiplication*, First Latin American School on Algebraic Geometry, La Cumbre, 2011.

- *Rigidity of spherical codes, and kissing numbers*, University of Cordoba, 2011.
- *Elliptic fibrations on Kummer surfaces*, Fields institute workshop on arithmetic and geometry of K3 surfaces and Calabi-Yau 3-folds, 2011.
- *Rigidity of spherical codes*, Workshop on sphere packing and amorphous materials, ICTP, Trieste, 2011.
- *Equations for Hilbert modular surfaces through K3 surfaces*, Stanford University Number theory seminar, 2011.
- *Jamming of spherical codes, Linear programming and Kissing numbers*, University of Calgary: Fejes Toth lecture in Discrete Geometry, 2011.
- *Packing problems and energy minimization*, University of Calgary math colloquium, 2011.
- *K3 surfaces and Hilbert modular surfaces*, Harvard University Number Theory seminar, 2011.
- *Jamming of spherical codes, Linear programming and Kissing numbers*, Northeastern University: Geometry-Algebra-Singularities-Combinatorics seminar, 2011.
- *Lattices, periodic configurations and Gaussian potential energy*, Joint Math Meetings (New Orleans), Special session on Quadratic forms, 2011.
- *Lattices, periodic configurations and Gaussian potential energy*, AMS - SOMACHI joint meeting (Pucon, Chile), Special session on Arithmetic of Quadratic forms and Integral Lattices, 2010.
- *Rigidity of Spherical codes, and Linear programming*, MIT Combinatorics seminar, 2010.
- *All the elliptic fibrations on a generic Jacobian Kummer surface*, Southern California Algebraic Geometry seminar, 2010.
- *K3 surfaces, genus 2 curves and Hilbert modular surfaces*, Michigan State university Algebra seminar, 2010.
- *All the elliptic fibrations on a generic Jacobian Kummer surface*, Harvard-MIT Algebraic Geometry seminar, 2010.
- *Explicit equations for Hilbert modular surfaces, and connections to modular forms*, ICM Satellite conference on Automorphic forms and Number theory at Goa, India, 2010.
- *Rigidity and Jamming properties of spherical codes*, Microsoft Research India (Bangalore), 2010.
- *All the elliptic fibrations on a generic Jacobian Kummer surface*, Humboldt Universitat: Workshop on Elliptic and K3 surfaces, 2010.
- *Energy minimization and connections with sphere packing and spherical codes*, (plenary talk) Vanderbilt University: conference on "Optimal Structures", 2010.
- *Inverse optimization problems: designing potential functions for target structures*, University of Hyderabad, 2010.
- Institute for Mathematical Sciences, Chennai, 2010. Lecture series:
  1. *Lattices, sphere packings, spherical codes and energy minimization*
  2. *K3 surfaces, Kummer surfaces and genus 2 curves*
  3. *Explicit equations for Hilbert modular surfaces*.
- *Hilbert modular surfaces through K3 surfaces*, Princeton University/IAS Number theory seminar, 2009.
- *Lattices, sphere packings, spherical codes, and energy minimization*, Emory University Algebra Seminar, 2009.
- *K3 surfaces and Hilbert modular surfaces*, AMS Southeastern Sectional Meeting, Special Session on Arithmetic Geometry, 2009.
- *Inverse optimization problems: designing potential functions for target structures*, University of Magdeburg: Algebra and Geometry seminar, 2009.
- *Parameterizing Hilbert modular surfaces via K3 surfaces*, Boston University Algebra Seminar, 2009.
- *K3 Surfaces, Shioda-Inose Structures, and Real Multiplication*, New York Joint Number theory seminar, 2009.
- *Configurations of points on spheres, and energy minimization*, MIT Geometry Seminar, 2008.
- *Lattices, sphere packings and potential energy minimization*, MIT Number theory seminar, 2008.
- *Lattices, Sphere packings and Energy minimization*, AMS Fall Sectional Meeting, Special Session in Number Theory, 2008.

- *Kummer surfaces, Shioda-Inose Structures, and real multiplication*, Québec-Vermont Number theory seminar, 2008.
- *Optimal geometric structures and Energy minimization*, Hausdorff Institute for Mathematics: workshop on Optimal Geometric Structures, 2008.
- *K3 surfaces and real multiplication*, Massachusetts Institute of Technology: Number theory seminar, 2007.
- *Linear Programming Bounds for Potential Energy and Universally Optimal Configurations*, Universite Catholique de Louvain (Belgium), A day in honor of Philippe Delsarte, 2007.
- *The* E_8 *and the Leech lattices in the context of energy minimization*, University of Talca (Chile), International conference on the algebraic and arithmetic theory of quadratic forms, 2007.
- *Elliptic surfaces and K3 surfaces*, Microsoft Research India (Bangalore), 2007.
- *K3 surfaces associated to genus 2 curves via Shioda-Inose structure*, Nagoya University, Conference on Birational automorphisms of compact complex manifolds and dynamical systems, 2007.
- *K3 Surfaces Corresponding To Genus 2 Curves*, Jacobs University Bremen, Workshop on Rational Points, 2007.
- *Uniqueness of some spherical codes related to the* E_8 *and Leech lattices*, University of Washington: Combinatorics seminar, 2007.
- *K3 surfaces of high rank and Kummer surfaces*, University of Washington: Number theory seminar, 2007.
- *The densest lattices in eight and twenty-four dimensions*, Microsoft Research India (Bangalore), 2006.
- *Universally optimal distribution of points on spheres*, Indian Institute of Science, 2006.
- *K3 surfaces of high rank and Kummer surfaces*, AMS Eastern Section Meeting, Special Session in Number theory, University of Connecticut, 2006.
- *Universally optimal distribution of points on spheres*, Brandeis University: Everytopic seminar, 2006.
- *K3 surfaces of high rank*, Harvard-MIT Algebraic Geometry seminar, 2006.
- *K3 surfaces with high Neron-Severi rank*, Columbia University: Algebraic Geometry seminar, 2006.
- *K3 surfaces with high Neron-Severi rank*, University of Pittsburgh: Mathematics Department colloquium, 2006.
- *K3 surfaces with high Neron-Severi rank*, University of Michigan: Number theory seminar, 2006.
- *K3 surfaces of high rank and isogenies to Kummer surfaces*, Microsoft Research, 2006.
- *The densest lattice in twenty-four dimensions*, Harvard University: Number theory seminar, 2005.
- *Optimality and uniqueness of the Leech lattice among lattices*, Kyushu University: Second COE Workshop on Sphere Packings, 2005.
- *Universally optimal distribution of points on spheres*, Calgary Workshop in Discrete Geometry, 2005.
- *The optimal lattice packing in* 24 *dimensions*, Wesleyan University: Algebra seminar, 2005.
- *Optimality and uniqueness of the Leech lattice among lattices*, Mathematisches Forschungsinstitut Oberwolfach: Workshop on Lattices and Applications, 2005.
- *The densest lattice packings in* 8 *and* 24 *dimensions*, American Institute of Mathematics: Workshop on Sphere packings, Lattices and Infinite dimensional algebra, 2004.
- *The optimal lattice packing in* 24 *dimensions*, Harvard University: Theory of computing seminar, 2004.
- *The optimal lattice packing in* 24 *dimensions*, Princeton University/IAS: Number theory seminar, 2004.

October, 2013