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Algebraic Geometry: Salt Lake City 2015

2015 Summer Research Institute
Algebraic Geometry
July 13–31, 2015
University of Utah, Salt Lake City, Utah

Tomasso de Fernex
Brendan Hassett
Mircea Mustaţă
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Editors

American Mathematical Society | Clay Mathematics Institute

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Preface

The 2015 American Mathematical Society Summer Institute on Algebraic Geometry was held July 13–31 at the University of Utah, in collaboration with the Clay Mathematics Institute. The six of us served as the organizing committee along with *ex officio* members Ellen Maycock (AMS) and Nick Woodhouse (CMI).

A total of 742 mathematicians from 28 countries attended over the three week period. The Summer Institute featured plenary lectures in the morning by 16 different speakers. The afternoons offered four parallel sessions in which 144 invited talks spread across 12 seminars were given, each 50 minutes long. There were also 72 contributed talks of 30 minutes each, as well as two poster sessions.

We are grateful to the seminar organizers: Bhargav Bhatt, Sébastien Boucksom, Jean-Louis Colliot-Thélène, David Eisenbud, Daniel Huybrechts, Yujiro Kawamata, Stefan Kebekus, Kiran Kedlaya, Minhyong Kim, János Kollár, Davesh Maulik, David Nadler, Sam Payne, Bjorn Poonen, Sug Woo Shin, Burt Totaro, Claire Voisin, and Annette Werner. Without their advice we could not have hoped to offer so broad a perspective on algebraic geometry.

The Summer Institute was preceded by the 'Graduate Student Bootcamp' led by İzzet Coşkun, Tommaso de Fernex, Angela Gibney, and Max Lieblich; this contributed very positively to the atmosphere of the meeting as whole. Manuscripts from this program will be published separately.

The contribution of the AMS cannot be overstated—it provided hundreds of hours of staff time at its own expense. AMS staff and management are largely responsible for the success of the Institute. The leadership of Ellen Maycock and Christine Stevens ensured we had the resources necessary to run the meeting, and the expertise of Robin Aguiar, Gina Alsfeld, Laura Byrum, Chris Davis, Lori Melucci, and Penny Pina ensured it ran smoothly. The National Science Foundation Division of Mathematical Science was our largest source of funding, through award 1447423. The Clay Mathematics Institute contributed funds to support plenary speakers and young international participants, as well as to stream and record all the invited lectures. The National Security Agency, the Simons Foundation, and the European Mathematical Society also provided key support.

Tommaso de Fernex
Brendan Hassett
Mircea Mustaţă
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Martin Olsson
Richard Thomas

Scientific program

Full details of the program are available at `https://sites.google.com/site/2015summerinstitute/`, the website of the Summer Institute. It also offers links to lecture notes and videos of invited talks.

First week

Plenary lectures

Serge Cantat: Groups of birational transformations
Simon Donaldson: Stability of algebraic varieties and Kähler geometry
Christopher Hacon and James McKernan: Birational geometry and moduli spaces of varieties of general type
Claire Voisin: Stable birational invariants and the Lüroth problem

Invited lectures

Valery Alexeev: Concrete functorial compactifications of moduli of K3 surfaces
Carolina Araujo: Foliations with positive tangent sheaf
Paul Aspinwall: Mirror symmetry and extremal transitions in the toric world
Sébastien Boucksom: K-stability, growth of functionals and singularities of pairs
Frédéric Campana: Pseudoeffectivity properties of orbifold cotangent bundles
Junyan Cao: Kodaira dimension of algebraic fiber spaces over abelian varieties
Paolo Cascini: Birational geometry and singularities in positive characteristic
Ana-Maria Castravet: Mori Dream Spaces
Fabrizio Catanese: Projective $K(\pi, 1)$ spaces and applications to moduli problems
Jungkai Chen: Geography of threefolds of general type
Aldo Conca: Multigraded ideals with a radical gin
Tommaso de Fernex: Birational geometry of projective hypersurfaces
David Eisenbud: Higher matrix factorizations for complete intersections: An introduction and an application
Gavril Farkas: The Green-Lazarsfeld secant conjecture
Osamu Fujino: On semi-log canonical pairs
Daniel Greb: Movable curves and semistable sheaves
Paul Hacking: Theta functions for K3 surfaces
Andreas Höring: MMP for compact Kähler threefolds
Stefan Kebekus: Higgs sheaves on singular spaces and the Miyaoka-Yau Inequality for minimal varieties of general type
Sándor Kovács: Projectivity of the moduli space of stable log-varieties
Radu Laza: Birational geometry of the moduli space of hyperelliptic quartic K3s
Robert Lazarsfeld: Syzygies of algebraic curves of large degree

Anton Leykin: Effective Noetherianity up to symmetry
Martin Möller: The volume of the moduli space of flat surfaces
Mircea Mustaţă: On the divisors computing minimal log discrepancies
Yoshinori Namikawa: A finiteness theorem for symplectic singularities
Kieran O'Grady: EPW sextics
Mihai Păun: Metric properties of direct images of twisted relative canonical bundles
Jorge Vitório Pereira: Adjoint dimension of foliations
Mihnea Popa: Positivity for Hodge modules and geometric applications
Claudiu Raicu: Characters of equivariant D-modules on spaces of matrices
Julius Ross: Variation of Gieseker moduli spaces via quiver GIT
Frank-Olaf Schreyer: Matrix factorizations and models of curves in $\mathbb{P}^4$
Karl Schwede: On the moduli part of the F-different
Gregory G. Smith: Nonnegativity certificates on real projective varieties
Andrew Snowden: Connections between commutative algebra and representations of categories
Frank Sottile: Galois groups of Schubert problems
Jason Starr: Spaces of rational curves on Fano manifolds
Mike Stillman: Applications of computational algebraic geometry to vacuum moduli spaces of supersymmetric models in physics
Song Sun: Singularities of Kähler-Einstein metrics and stability
Gábor Székelyhidi: The equivariant Yau-Tian-Donaldson conjecture
Shunsuke Takagi: Frobenius action on local cohomology and the Hodge filtration
Valentino Tosatti: Nakamaye's theorem on complex manifolds
Frédéric Touzet: Compact leaves of codimension one holomorphic foliations
Dror Varolin: A survey of L^2 Extension and its applications in analytic and algebraic geometry
Jörg Winkelmann: On h-principle on specialness
David Witt Nyström: Growth conditions associated to ample (or big) line bundles
Chenyang Xu: Dual complex of singular pairs

Contributed lectures

Benjamin Bakker: Bounding torsion in geometric families of abelian varieties
Morgan Brown: Homotopy equivalence of Berkovich spaces via birational geometry
Sebastian Casalaina-Martin: On descending cohomology geometrically
Dan Edidin: Strong regular embeddings and the geometry of hypertoric stacks
Taro Fujisawa: Limits of Hodge structures in several variables
Patrick Graf: The jumping coefficients of non-$\mathbb{Q}$-Gorenstein multiplier ideals
Gordon Heier: Holomorphic sectional curvature and the structure of projective Kähler manifolds
Mattias Jonsson: Degenerations of Calabi-Yau manifolds and Berkovich spaces
Martí Lahoz: Rational cohomology tori
Adrian Langer: Higgs sheaves in positive characteristic
John Lesieutre: Constraints on threefolds admitting positive entropy automorphisms
Anatoly Libgober: Sections of Pfaffians
Daniel Lowengrub: A cancellation theorem for Segre classes
Angela Ortega: The Prym map of degree-7 cyclic coverings

Karol Palka: The geometry of rational cuspidal curves in the complex projective plane
Bangere Purnaprajna: Fundamental groups and Shafarevich conjecture on holomorphic convexity
Sönke Rollenske: Gorenstein stable surfaces with $K^2 = 1$
Justin Sawon: Lagrangian fibrations
Hendrik Suess: Torus equivariant K-stability in complexity one
Tomasz Szemberg: Sylvester-Gallai and beyond
Behrouz Taji: On a conjecture of Shafarevich and Campana
Sofia Tirabassi: Deformations of minimal cohomology classes
Nikolaos Tziolas: Automorphisms of canonically polarized surfaces in positive characteristic
Kei-ichi Watanabe: p_g-ideals and core of integrally closed ideals in normal surface singularities

Second week

Plenary lectures

Tom Bridgeland: Stability and wall-crossing
Mark Gross: Mirror symmetry
Maxim Kontsevich: Mirror symmetry: new definitions
Jacob Lurie: Cohomology theories and commutative rings; Representation theory in intermediate characteristic; and Roots of unity in intermediate characteristic
Bao Châu Ngô: Singularities in formal arc spaces and harmonic analysis over non-archimedean fields
Andrei Okounkov: Enumerative geometry and representation theory
Rahul Pandharipande: Cycles on the moduli space of curves

Invited lectures

Dan Abramovich: Artin fans
Nick Addington: Exoflops
Mina Aganagic: Instant counting, W-algebras and the little string
Omid Amini: Limit linear series and distribution of Weierstrass points
Dima Arinkin: Moduli of regular connections on the punctured disk
Matt Ballard: Orlov spectra in algebraic geometry and beyond
Arend Bayer: Stability and wall-crossing: applications to classical algebraic geometry
Roman Bezrukavnikov: Geometric Langlands and Bridgeland stabilities
Lev Borisov: Equality of stringy E-functions of Pfaffian double mirrors and related results
Jim Bryan: Elliptically fibered Calabi-Yau threefolds, Jacobi-Forms, and the topological vertex
Lucia Caporaso: Degenerations of line bundles on algebraic curves: new methods and results
Dustin Cartwright: Combinatorial tropical surfaces
Melody Chan: Topology of the tropical moduli spaces of curves
John Francis: Poincaré/Koszul duality
Walter Gubler: Skeletons and tropicalizations

Dan Halpern-Leistner: Θ-reductive moduli problems, stratifications, and applications
Tamás Hausel: Arithmetic of wild character varieties
Hiroshi Iritani: Constructing mirrors via shift operators
David Jensen: Tropical independence and the maximal rank conjecture for quadrics
Maxim Kontsevich: Iterated stability
Kobi Kremnizer: Towards a p-adic Riemann-Hilbert correspondence
Yuan-Pin Lee: Birational transformation and degeneration in Gromov-Witten theory
Jun Li: Mixed-Spin-P fields and algorithm to evaluate GW and FJRW invariants of quintic CY manifolds
Melissa Liu: On the remodeling conjecture for toric Calabi-Yau 3-orbifolds
Emanuele Macrì: Bridgeland stability conditions on higher dimensional varieties
Hannah Markwig: Tropicalizing rational relative Gromov-Witten theory of $\mathbb{P}^1$
David Nadler: Singular Lagrangians
Tom Nevins: D-modules on stacks from the GIT point of view
Johannes Nicaise: Refined curve counting and Hrushovski-Kazhdan motivic integration
Tony Pantev: Shifted deformation quantization
Sam Payne: Tropical methods in Brill-Noether theory
Aaron Pixton: Ranks of tautological rings
Jon P. Pridham: A concrete approach to higher and derived stacks
Joe Rabinoff: Uniform bounds on rational points via p-adic integration and Berkovich skeletons
Nick Rozenblyum: Algebro-geometric aspects of higher quantization
Yongbin Ruan: A mathematical theory of gauged linear sigma model (GLSM)
Vivek Shende: Legendrian knots and moduli spaces of microlocal sheaves
Nick Sheridan: Counting curves using the Fukaya category
Paolo Stellari: Uniqueness of dg enhancements in geometric contexts and Fourier-Mukai functors
Richard Thomas: Homological projective duality
Yukinobu Toda: Non-commutative thickening of moduli spaces of stable sheaves
Gabriele Vezzosi: Recent directions in Derived Geometry
Michael Wemyss: Aspects of the Homological Minimal Model Program
Annette Werner: Sections of tropicalization maps
Chris Woodward: Quantum K-theory of geometric invariant theory quotients
Zhiwei Yun: Intersection numbers of cycles on the moduli of Shtukas
Xinwen Zhu: The geometric Satake isomorphism for p-adic groups
Dimitri Zvonkine: Double ramification cycles

Contributed lectures

Marcello Bernardara: Homological projective duality for determinantal varieties
Andrei Căldăraru: Algebraic proofs of degenerations of Hodge-de Rham complexes
Giulio Codogni: Schottky problem, quadratic forms and Satake compactifications
María Angélica Cueto: Repairing tropical curves by means of linear tropical modifications
Olivia Dumitrescu: From Cellular Graphs to TQFT
Carel Faber: Teichmüller modular forms

Jack Hall: Coherent Tannaka duality
Yunfeng Jiang: Quantum cohomology of hypertoric DM stacks and Monodromy Conjecture
Jesse Kass: What is the universal theta divisor, really?
Sheldon Katz: BPS invariants of elliptically fibered Calabi-Yau threefolds and Jacobi forms
Eric Larson: Interpolation for curves in projective space
Naichung Conan Leung: Witten deformation and scattering diagram in A-model
Jason Lo: t-structures on elliptic fibrations
Travis Mandel: Tropical curve counting and canonical bases
Eyal Markman: A survey of hyperholomorphic bundles in hyperkähler geometry
Cristian Martinez: Change of polarization for moduli spaces of sheaves as Bridgeland wall-crossing
Dave Morrison: Periods, Gromov-Witten invariants, and the Mukai pairing
Helge Ruddat: Canonical Calabi-Yau families
David Rydh: Local structure of Artin stacks
Giulia Saccà: Symplectic singularities and quiver varieties
Artan Sheshmani: On the proof of the S-duality modularity conjecture for the quintic threefold
David Swinarski: Vector partition functions for conformal blocks
Filippo Viviani: Fourier-Mukai and autoduality for compactified Jacobians
Tony Yue Yu: First steps of non-archimedean enumerative geometry

Third week

Plenary lectures

Hélène Esnault: Some fundamental groups in arithmetic geometry
Mark Kisin: Integral models of Shimura varieties
Shou-Wu Zhang: Faltings heights and Zariski density of CM abelian varieties
Peter Scholze: p-adic Hodge theory and q-de Rham cohomology

Invited lectures

Aravind Asok: Vector bundles and A^1-homotopy theory
Joseph Ayoub: Conjectures on motives and algebraic cycles
Rebecca Bellovin: Local ε-isomorphisms in families
Laurent Berger: Iterated extensions and relative Lubin-Tate groups
Nicolas Bergeron: Special cycles in ball quotients and moduli spaces of quasi-polarized K3 surfaces
Bhargav Bhatt: Perfect algebraic geometry
Patrick Brosnan: Nilpotent orbits in Hodge theory
Tim Browning: Counting failures of weak approximation
Anna Cadoret: Specialization of adelic representations of étale fundamental groups of schemes
Bryden Cais: On F-crystalline representations
Pierre Colmez: Locally analytic representations de $\mathrm{GL}_2(\mathbf{Q}_p)$ and coverings of Drinfeld's upper half plane.
Ishai Dan-Cohen: Towards Chabauty-Kim loci for the polylogarithmic quotient over an arbitrary number field

Johan de Jong: Local Picard groups
Laurent Fargues: From local class field theory to the curve and vice versa
Tom Fisher: On families of n-congruent elliptic curves
Roger Heath-Brown: Rational points on intersections of quadrics
Eugen Hellmann: Degenerations of trianguline representations
Yuichiro Hoshi: Classical p-adic Teichmuller theory in characteristic three
Eric Katz: Uniform bounds on rational and torsion points on curves
Kiran Kedlaya: (ϕ, Γ)-modules on analytic, adic, and perfectoid spaces
Moritz Kerz: K-theory of non-Archimedean algebras and spaces
Bruno Klingher: An André-Oort conjecture for variations of Hodge structures
Daniel Krashen: Field patching and higher dimensional local-global principles
Max Lieblich: Twisted sheaves, ten years later
Ruochuan Liu: Finiteness of cohomology of relative (ϕ, Γ)-modules.
Melanie Matchett Wood: Heuristics for boundedness of ranks of elliptic curves
Wieslawa Niziol: Syntomic complexes and p-adic nearby cycles.
Emmanuel Peyre: The upgraded version of Batyrev-Manin program
Alena Pirutka: On stable rationality
Jonathan Pottharst: On the parity conjecture in p-adic analytic families
Mohamed Saidi: On the Grothendieck anabelian section conjecture over finitely generated fields
Shuji Saito: Motives with modulus
Takeshi Saito: The characteristic cycle and the singular support of an étale sheaf
Tomer Schlank: Stable obstruction to degree one zero cycles
Stefan Schreieder: The construction problem for Hodge numbers
Romyar Sharifi: Modular symbols and arithmetic
Sug Woo Shin: From Langlands-Rapoport conjecture to cohomology of Shimura varieties
Alexei Skorobogatov: Variation of the Selmer group of quadratic twists and the Hasse principle for Kummer varieties
Junecue Suh: New vanishing theorems for mixed Hodge modules and applications
Tamás Szamuely: Variations on a theme by Ribet
Akia Tamagawa: Specialization of ℓ-adic representations of arithmetic fundamental groups and applications to arithmetic of abelian varieties
Zhiyu Tian: Fundamental group of Fano varieties
Yuri Tschinkel: Almost abelian anabelian geometry
Takeshi Tsuji: On p-adic etale cohomology of perverse sheaves
Douglas Ulmer: Ranks of abelian varieties over function fields
Anthony Várilly-Alvarado: Kodaira dimension of certain orthogonal modular varieties
Kirsten Wickelgren: Splitting varieties for triple Massey products in Galois cohomology
Olivier Wittenberg: On the fibration method for zero-cycles and rational points

Contributed lectures

Asher Auel: Brill-Noether special cubic fourfolds
Ana Maria Botero: On the integrability of b-divisors on toric varieties

Charlotte Chan: p-adic Deligne-Lusztig constructions and the local Langlands correspondence
Carl Erickson: Singularities along the Eisenstein locus of the ordinary eigencurve
Richard Hain: Mixed motives associated to classical modular forms
David Holmes: A Néron model of the universal Jacobian
Sean Howe: p-adic modular forms and the Hodge-Tate period map
Lars Kindler: Ramification theory for D-modules in positive characteristic
Ching-Jui Lai: Surfaces with maximal canonical degree
Swarnava Mukhopadhyay: Strange duality of conformal blocks and nef divisors on $\overline{M}_{0,n}$
Andrew Niles: The Picard groups of the stacks $Y_0(2)$ and $Y_0(3)$
Andrew Obus: A generalization of the Oort conjecture
Marta Pieropan: Generalized Cox rings over non closed fields
Will Sawin: Applications of algebraic geometry to analytic number theory
Padmavathi Srinivasan: Conductors and discriminants for a class of hyperelliptic curves
Peter Stiller: Aspects of algebraic geometry in computer vision
Roberto Svaldi: Hyperbolicity for log pairs
Yunqing Tang: Algebraic solutions of differential equations over the projective line minus three points
Sho Tanimoto: Towards a refinement of Manin's conjecture
Nicola Tarasca: Loci of curves with subcanonical points in low genus
Jean-Baptiste Teyssier: Nearby slopes. Applications and open problems
Adam Topaz: On mod-ℓ birational anabelian geometry
Jesse Wolfson: Topology and arithmetic of resultants
David Zureick-Brown: The canonical ring of a stacky curve

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