Rainer Sinn **Curriculum Vitae**
rainer.sinn@uni-leipzig.de http://www.math.uni-leipzig.de/~sinn/index_en.html

Current Status

Since 2020: Professor for Applied Algebra (W2 - associate) at Universität Leipzig

Previous Positions

2017 - 2020: Juniorprofessor for Discrete Geometry at Freie Universität Berlin, acting head of the working group from July 2018 until September 2020
2017: Member of the Nonlinear Algebra Group at the Max-Planck-Institute for Mathematics in the Sciences, Leipzig, Germany
2014 - 2017: Visiting Assistant Professor at the Georgia Institute of Technology, Atlanta

Degrees

- PhD: Doktor der Naturwissenschaften (summa cum laude) May 2014; Advisor: Claus Scheiderer
- Diploma Degree in Mathematics (grade 1.0) 2010

Education

- Universität Konstanz, PhD student 2010 - 2014
- Université Paris Diderot Paris VII, Exchange student 2008/09
- Universität Konstanz, Student 2004-2009

Research Interests

Algebraic, convex, discrete, real geometry

- Positive polynomials and sums of squares
- Matrix inequalities and moment relaxations
- Convex, semi-algebraic sets

Grants and Awards

- MaRDI (joint project as part of NFDI), part of TA6: Data Culture and Community Integration
- DFG Project „Geometry of hyperbolic polynomials“ (with Daniel Plaumann)
- Simons-Berkeley Research Fellowship (to attend *Geometry of Polynomials*, Spring 2019)
- [Pegasus]^2 Marie Skłodowska-Curie Fellowship of the FWO (three year postdoc grant, moved to FU Berlin instead)
- Oct 2011 - Mar 2014: PhD fellowship with the German National Academic Foundation
- Sep 2008 - Mar 2010: Student fellowship with the German National Academic Foundation

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Extended Stays

- January - May 2019: Simons Institute - Semester Program *Geometry of Polynomials*
- September - October 2018: ICERM - Semester Program *Nonlinear Algebra*
- August - September 2017: MSRI - Semester Program *Geometric and Topological Combinatorics* (Research Membership)
- May - July 2014: National Institute of Mathematical Sciences, Daejeon, South Korea - *Thematic Program on Applied Algebraic Geometry*

Publications

1. *Adjoints and Canonical Forms of Polypols*, with Kathlén Kohn, Ragni Piene, Kristian Ranestad, Felix Rydell, Boris Shapiro, Miruna-Stefana Sorea, and Simon Telen, Preprint 2021.
   https://arxiv.org/abs/2108.11747
2. *Do alcoved lattice polytopes have unimodal h^*-vector*, with Hannah Sjöberg, Preprint, 2021.
   https://arxiv.org/abs/2104.15080
3. *Families of Faces and the Normal Cycle of a Convex Semi-algebraic Set*, with Daniel Plaumann and Jannik Lennart Wesner, Preprint, 2021.
   https://arxiv.org/abs/2104.13306
4. *On the Existence of Two View Chiral Reconstructions*, with Andrew Pryhuber and Rekha Thomas, Preprint, 2020.
   https://arxiv.org/abs/2011.07197
5. *The Chiral Domain of a Camera Arrangement*, with Sameer Agarwal, Andrew Pryhuber, and Rekha Thomas, Preprint, 2020.
   https://arxiv.org/abs/2003.09265
6. *Hyperbolic Secant Varieties of M-Curves*, with Mario Kummer, Preprint, 2020.
   https://arxiv.org/abs/2002.00486
7. *Maximum Likelihood Estimation for Nets of Conics*, with Stefan Dye, Kathlén Kohn, and Felix Rydell, to appear in Le Matematiche.
   https://arxiv.org/abs/2011.08989
8. *Sums of Squares and Quadratic Persistence on Real Projective Varieties*, with Grigoriy Blekherman, Gregory G. Smith, and Mauricio Velasco, to appear in the Journal of the EMS.
   https://arxiv.org/abs/1902.02754
9. *Sums of Squares: A real projective story*, mit Grigoriy Blekherman, Gregory G. Smith und Mauricio Velasco.
   Notices of the AMS, **68(5)**, 734-747, 2021

10. *On the Dimensions of the Realization Spaces of Polytopes*, with Laith Rastanawi and Günter Ziegler.
    Mathematika, **67(2)**, 342-365, 2021
11. *Conic Programming: Infeasibility Certificates and Projective Geometry*, with Simone Naldi.
    Journal of Pure and Applied Algebra, **225(7)**, 22 pages, 2021
12. *Kippenhahn's Theorem for Joint Numerical Ranges and Quantum States*, with Daniel Plaumann and Stephan Weis.
    SIAM Journal on Applied Algebra and Geometry, **5(1)**, 86-113, 2021
13. *Combinatorial Inscribability Obstructions for Higher-dimensional Polytopes*, with Joseph Doolittle, Jean-Philippe Labbé, Carsten Lange, Jonathan Spreer, and Günter Ziegler.
    Mathematika, **66(4)**, 927-953, 2020
14. *Typical and Generic Ranks in Matrix Completion*, with Daniel Bernstein and Grigoriy Blekherman.
    Linear Algebra and its Applications, **585**, 71-104, 2020
15. *Positive Semidefinite Univariate Matrix Polynomials* , with Christoph Hanselka.
    Mathematische Zeitschrift, **292(1-2)**, 83-101, 2019
16. *Maximum Likelihood Threshold and Generic Completion Rank of Graphs*, with Grigoriy Blekherman.
    Discrete and Computational Geometry, **61(2)**, 303-324, 2019
17. *Gram Spectrahedra*, with Lynn Chua, Daniel Plaumann, and Cynthia Vinzant.
    In Ordered Algebraic Structures and Related Topics, vol. 697 of Contemporary Mathematics, 81-105. American Mathematical Society, Providence, RI, 2017
18. *Do Sums of Squares Dream of Free Resolutions?* with Grigoriy Blekherman and Mauricio Velasco.
    SIAM Journal on Applied Algebra and Geometry **1(1)**, 175-199, 2017
19. *Low-Rank Sum-of-Squares Representations on Varieties of Minimal Degree*, with Grigoriy Blekherman, Daniel Plaumann, and Cynthia Vinzant.
    International Mathematical Research Notices, **2019(1)**, 33-54, 2019
20. *Extreme Rays of the Hankel Spectrahedra for Ternary Forms*, with Grigoriy Blekherman.
    Journal of Symbolic Computation **79 (1)**, 23-42, 2017
21. *Real Ranks with Respect to Varieties*, with Grigoriy Blekherman.
    Linear Algebra and its Applications, **505**, 344-360, 2016
22. *Computing hermitian determinantal representations of hyperbolic curves*, with Daniel Plaumann, David E Speyer, and Cynthia Vinzant.
    International Journal of Algebra and Computation, **25 (8)**, 1327-1336, 2015

23. *Generic Spectrahedral Shadows,* with Bernd Sturmfels.
    SIAM Journal on Optimization, **25 (2)**, 1209-1220, 2015
24. *Algebraic Boundaries of Convex Semi-algebraic Sets.*
    Research in the Mathematical Sciences, **2 (1)**, 2015
25. *Algebraic Boundaries of Convex Semi-algebraic Sets,* PhD thesis, 2014.
    http://nbn-resolving.de/urn:nbn:de:bsz:352-281616
26. *Algebraic Boundaries of SO(2)-Orbitopes.*
    Discrete and Computational Geometry, **50 (1)**, 219-235, 2013

Publications (non-reviewed)

1. Sums of Squares on Projective Varieties, Oberwolfach Report 14/2017.
   https://www.mfo.de/occasion/1710/www_view

Graduate Students

1. Marie-Charlotte Brandenburg
2. Chiara Meroni (IMPRS, MPI Leipzig)
3. Laith Rastanawi (joint with Günter Rote, FU Berlin)
4. Jannik Wesner (joint with Daniel Plaumann, TU Dortmund)

Graduated Students

1. Hannah Sjöberg (joint with Günter Ziegler, FU Berlin)

Seminar Talks

- Numerical Algebra and Optimization Seminar, MPI Leipzig
  Chirality in Computer Vision (2021)
- Seminar on Nonlinear Algebra, MPI Leipzig
  Adjoints and Canonical Forms of Polypols (2021)
- Discrete Mathematics/Geometry Seminar, TU Berlin
  Realization Spaces of Polytopes (2020)
- Nonlinear Algebra Seminar Online, Max-Planck Institute Leipzig
  Chirality from Multiple Views (2020)
- Algebra, Geometry, Combinatorics Seminar, San Francisco State University
  Local Properties of Realization Spaces of Polytopes (2019)
- Introduction to Algebraic Statistics by Bernd Sturmfels, Freie Universität Berlin
  The Cone of Sufficient Statistics (Invited Lecture, 2018)
- Seminar Algorithmic Algebra, Technische Universität Berlin
  Quadratic Persistence of Real Projective Varieties (2018)
- Discrete Geometry Seminar, Freie Universität Berlin
  Matrix Completion Problems from the Geometric Point of View (2017)

- Algebra Geometry Combinatorics Seminar, San Francisco State University
  Positive Semidefinite Matrix Completion and Free Resolutions (2017)
- Geometric and Topological Combinatorics Seminar, MSRI, Berkeley
  Positive Semidefinite Matrix Completion and Free Resolutions (2017)
- Nonlinear Algebra Seminar, Max-Planck Institute Leipzig
  Positive Semidefinite Matrix Completion and Sums of Squares (2017)
- Colloquium Methods for Discrete Structures, Free University Berlin
  Positive Semidefinite Matrix Completion (2017)
- Computational Algebra Seminar, North Carolina State University, Raleigh, NC
  Pythagoras Number of Real Projective Varieties (2017)
- TU Eindhoven
  Geometry of Sums of Squares (2017)
- Technical University Berlin
  Geometry of Sums of Squares (2017)
- Trends in Optimization Seminar, University of Washington, Seattle
  Positive semidefinite matrix completion and sums of squares (2016)
- Seminar Discrete Geometry, Free University Berlin
  Geometry of Sums of Squares (2016)
- Combinatorics Seminar, University of Miami, Miami
  Positive semidefinite matrix completion and free resolutions (2016)
- Algebraic Geometry Seminar, University of Illinois, Urbana-Champaign
  Sums of Squares on Projective Varieties (2016)
- Algebra Seminar, Osnabrück, Germany
  Positive Semidefinite Matrix Completion, Sums of Squares, and Free Resolutions (2016)
- Oberseminar Reelle Geometrie und Algebra, Konstanz, Germany
  Low-Rank Sum-of-Squares Representations on Varieties of Minimal Degree (2016)
- Algebra Seminar, Emory University, Atlanta, GA
  Matrix Competion and Free Resolutions (2016)
- Geometry Seminar, Texas A&M, College Station, TX
  Matrix Completion and Small Schemes (2016)
- Colloquium at Georgia Southern, Statesboro, GA
  Sums of Squares and Projective Varieties (2015)
- Oberseminar Reelle Geometrie und Algebra, Konstanz, Germany
  Generic Spectrahedral Shadows (2015)
- Oberseminar Diskrete Mathematik, Frankfurt, Germany
  Generische Projizierte Spektraeder (2015)
- Computational Algebra Seminar, North Carolina State University, Raleigh, NC
  Generic Spectrahedral Shadows (2015)

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Conference Talks

- Numerical and Probabilistic Nonlinear Algebra, MPI Leipzig
  Image Reconstruction and Chirality in Computer Vision (2021)
- Degeneracy Loci and Applications, online
  Spectrahedra (2021)
- POEMA 2nd Workshop, online
  Kippenhahn's Theorem for Joint Numerical Ranges (2020)
- Workshop Computational Algebra, online
  Realization Spaces of Polytopes (2020)
- Opening Conference of the Thematic Einstein Semester Algebraic Geometry, FU Berlin
  Sums of Squares and Projective Varieties (2019)
- ICCOPT, Berlin, Germany
  Kippenhahn's Theorem in Higher Dimensions (2019)
- SIAM Conference on Applied Algebraic Geometry, Bern, Switzerland
  Real Geometry of Matrix Completion (2019)
- BIRS Workshop Geometry of Real Polynomials, Convexity and Optimization, Banff, Canada
  Kippenhahn's Theorem for the Joint Numerical Range (2019)
- Geometry of Polynomials Boot Camp, Simons Institute for the Theory of Computing, Berkeley, CA
  Hyperbolic Polynomials and Determinantal Representations I and II (2019)
- Symposium on Discrete Mathematics, TU Graz, Austria
  Graph invariants from positive semidefinite matrix completion (2018)
- GDMV 2018, Paderborn, Germany
  Sektion Diskrete Mathematik und Computeralgebra
  Matrixvervollständigung vom geometrischen Standpunkt (2018)
- Geometrietag 2017, Magdeburg, Germany
  Quadratic Persistence of Projective Varieties (2017)
- BMS-BGSMath Keynote Lecture, Barcelona
  Extension Complexity and the Matching Polytope (2017)
- SIAM Conference on Applied Algebraic Geometry, Atlanta, GA
  Minisymposium on Convex Algebraic Geometry and Semidefinite Optimization
  Sum-of-Squares Representations of Shortest Length (2017)
- Oberwolfach Workshop Real Algebraic Geometry with a View Toward Moment Problems and Optimization, Oberwolfach
  Sums of Squares on Projective Varieties (2017)
- Joint Mathematics Meeting, Atlanta, GA
  Special Session on Gaussian Graphical Models and Combinatorial Algebraic Geometry
  Positive Semidefinite Matrix Completion and Algebraic Geometry (2017)

- Harmony of Real and Complex Algebraic Geometry, Deajeon, South Korea
  Matrix Completion and Free Resolutions I and II (2016)
- AMS Sectional Meeting, Raleigh, NC
  Special Session on Applied Algebraic Geometry
  More on the Geometry of Positive Semidefinite Matrix Completion (2016)
- ALaNT 4, Telč, Czech Republic
  Sums of Squares and Positive Semidefinite Matrix Completion (2016)
- GOAL Workshop, Paris, France
  Gaussian Graphical Models and Regularity (2016)
- Applied Algebra Days 3, Madison, WI
  Sums of Squares and Maximum Likelihood Estimation (2016)
- AMS Sectional Meeting, Fargo, ND
  Special Session on Combinatorial Ideals and Applications
  Matrix Completion, Free Resolutions, and Sums of Squares (2016)
- AMS Sectional Meeting, Athens, GA
  Special Session on Discrete and Applied Algebraic Geometry
  Low rank psd lifts of nonnegative quadratic forms (2016)
- Joint Mathematics Meeting, Seattle, WA
  Special Session on Nonlinear Algebra
  Real Rank with Respect to Varieties (2016)
- Algebra, Geometry, and Proofs in Symbolic Computation, Fields Institute, Toronto, Canada
  Sums of Squares on Projective Varieties (2015)
- Ordered Algebraic Structures and Related Topics, CIRM Workshop, Luminy, France
  Gram Spectrahedra (2015)
- Third Workshop on Hybrid Methodologies for Symbolic-Numeric Computation (embedded meeting of ICIAM 2015), Beijing, China
  Algebraic Boundaries of Convex Sets (2015)
- SIAM Conference on Applied Algebraic Geometry, Daejeon, South Korea
  Generic Spectrahedral Shadows (2015)
- Nonlinear Algebra, Berlin, Germany
  Gram Spectrahedra (2015)
- Optimization and Algebraic Geometry, Daejeon, South Korea
  Extreme Rays of the Hankel Spectrahedra for Ternary Forms (2014)
- Polyhedra, Lattices, Algebra and Moments, Singapore
  Extreme Rays of Cones of Moment Matrices for Ternary Forms (2014)
- SIAM Conference on Applied Algebraic Geometry, Fort Collins
  Algebraic Boundaries of Convex Semi-algebraic Sets (2013)

- SIAM Conference on Applied Algebraic Geometry, Raleigh, NC
  The Algebraic Boundary of SO(2)-Orbitopes (2011)
- Real Algebraic Geometry, Rennes, France
  SO(2)-Orbitopes (2011)
- Real Algebra, Geometry and Convexity, Leipzig, Germany
  SO(2)-Orbitopes (2011)

Organization

- Minisymposium "Convex Algebraic Geometry" at SIAM Conference on Applied Algebraic Geometry 2021, with Greg Blekherman and Cynthia Vinzant, in College Station, TX, USA (2021)
- Fall School of the Thematic Einstein Semester on Algebraic Geometry - Varieties, Polyhedra, Computation, with Daniele Agostini, Thomas Krämer, Marta Panizzut, at FU Berlin (2019)
- Real Applied Algebraic Geometry, with Mario Kummer and Bernd Sturmfels at TU Berlin (2019)
- Convexity Day at MPI Leipzig with Thomas Wannerer, in Leipzig (2019)
- Minisymposium „Algebraic Methods for Convex Sets" at SIAM Conference on Applied Algebraic Geometry 2019, with Greg Blekherman, Daniel Plaumann, Yong Sheng Soh, and Dogyoon Song, in Bern, Switzerland (2019)
- Visit by Rekha Thomas as a guest of the research training group Facets of Complexity at FU Berlin (June 2019)
- Berlin-Leipzig Seminar on Algebra, Geometry, and Combinatorics
  Two-day conference at FU Berlin, with Christian Haase (2017)
- Reading Group on Real Algebraic Geometry with Mario Kummer and Kristin Shaw at MPI Leipzig (2017)
- Joint Mathematics Meeting in Atlanta, GA
  Special Session on Gaussian Graphical Models and Combinatorial Algebraic Geometry (2017)
- Minisymposium "Polynomial Optimization and Moments" at SIAM Conference on Applied Algebraic Geometry 2015 in Daejeon, South Korea

Teaching Experience

Lectures

- Algebra I (U Leipzig 2021/22)
- Real Algebra and Geometry (U Leipzig 2021)
- Linear Algebra II (U Leipzig 2021)
- Riemann surfaces and algebraic curves (U Leipzig 2020/21)
- Linear Algebra I (U Leipzig 2020/21)

- Linear Algebra II (FU Berlin 2020)
- Linear Algebra I (FU Berlin 2019/20)
- Mathematical Panorama (FU Berlin 2018/2019)
- Discrete Geometry III (FU Berlin 2018/2019)
- Discrete Geometry II (FU Berlin 2018)
- Discrete Geometry I (FU Berlin 2017/2018)
- MATH-4150 Introduction to Number Theory (GT Spring 2017)
- MATH-8803-sin Algebraic Curves (GT Fall 2016)
- MATH-2552 Differential Equations (GT Spring 2016)
- MATH-1552 Integral Calculus (GT Fall 2015)
- MATH-4150 Introduction to Number Theory (GT Spring 2015)
- MATH-2403 Differential Equations (GT Fall 2014)

Seminars

- Seminar on Topics in Algebra and Geometry (U Leipzig 2021/22)
- Seminar Real Algebraic Geometry and Optimization (FU Berlin 2019)
- Proseminar Panorama der Mathematik (Storytelling in Mathematics) (FU Berlin 2019)
- Topics from Number Theory and Algebraic Geometry (Konstanz 2010/2011)

Summer Schools

- Summer School on Hyperbolic Polynomials, Sums of Squares, and Optimization, (Georgia Institute of Technology, organization Greg Blekherman, 2018)
- Summer School on Real Algebraic Geometry and Optimization (Georgia Institute of Technology, organization Greg Blekherman 2016)

Service

- Reviews: Alexander von Humboldt Stiftung, various journals (including DCG, IMRN, Journal of Algebra, Linear and Multilinear Algebra, SIOPT, SIAGA)
- Committees: TA selection committee (FU Berlin; 06/2018–09/2020), Hiring committees (for two postdoc positions), BMS Committee (10/2019–09/2020), Postdoc Hiring committee for the Nonlinear Algebra group at MPI MiS Leipzig (2020)

Conferences (Selection)

- SIAM Conference on Applied Algebraic Geometry, College Station, TX, USA (2021)
- Oberwolfach Workshop „Real Algebraic Geometry with a View toward Hyperbolic Programming and Free Probability“ (2020)
- SIAM Conference on Applied Algebraic Geometry, Bern, Switzerland (2019)
- BIRS Workshop Geometry of Real Polynomials, Convexity and Optimization, Banff, Canada (2019)

- Simons Workshops on Geometry of Polynomials (2019)
- SIAM Conference on Applied Algebraic Geometry, Atlanta, GA (2017)
- Real Algebraic Geometry with a View Toward Moment Problems and Optimization, Oberwolfach Workshop (2017)
- Joint Mathematics Meeting in Atlanta, GA (2017)
- Joint Mathematics Meeting in Seattle, WA (2016)
- Algebra, Geometry, and Proofs in Symbolic Computation, Fields Institute, Toronto, Canada (2015)
- Ordered Algebraic Structures and Related Topics, CIRM Workshop, Luminy, France (2015)
- Algebraic Vision, Berlin, Germany (2015)
- SIAM Conference on Applied Algebraic Geometry, Daejeon, South Korea (2015)
- Real Algebraic Geometry with a View to Systems Control and Free Positivity, Oberwolfach, Germany (2014)
- SIAM Conference on Applied Algebraic Geometry, Fort Collins, CO (2013)
- Workshop Polynomial Optimisation, Isaac Newton Institute, Cambridge, UK (2013)
- Structured Function Systems and Applications, Oberwolfach, Germany (2013)
- SIAM Conference on Applied Algebraic Geometry, Raleigh, NC (2011)
- Real Algebraic Geometry, Rennes, France (2011)
- BIRS Workshop Convex Algebraic Geometry, Banff, Canada (2010)

Languages

German (native language)
English (fluent)
French (good)

Mailing Address

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Physical Address

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