Max Planck Institute for
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Fulvio Gesmundo

Personal Information

born in Florence (Italy), on January 20th, 1987
Italian Citizenship

Education

2013 – 2017 **Ph.D. in Mathematics at Texas A&M University**.
Advisor: Prof. J.M. Landsberg
Graduation: May 2017
Thesis: Geometry and Representation Theory in the Study of Matrix Rigidity

2010 – 2012 **M.S. in Mathematics at Università degli Studi di Firenze (University of Florence)**.
Advisor: Prof. Giorgio Ottaviani.
Graduation: April 2012.
Thesis : Rango di tensori e Varietà Secanti
(Tensor Rank and Secant Varieties)

2006 – 2010 **B.S. in Mathematics at Università degli Studi di Firenze (University of Florence)**.
Advisor: Prof. Donato Pertici.
Graduation: April 2010.
Thesis: Spazi Completamente Regolari e Compattificazione di Stone-Čech
(Completely Regular Spaces and Stone-Čech Compactification)

Awards

May 2017 *L.F. Guseman Prize* - May 1st, 2017 - College Station, TX

May 2016 *Bush School Travel Grant* - May 20th, 2016 - College Station, TX

March 2013 *Premio di Laurea Luigi Campedelli* (*Luigi Campedelli Thesis Prize*) for my Master's Thesis - March 11th, 2013 - Florence, Italy

Work experience

2020 – **PostDoc**
Max Planck Institute for Mathematics in the Sciences, Leipzig. Nonlinear Algebra Group.

2017 – 2020 **PostDoc**
University of Copenhagen. QMATH – Department of Mathematical Sciences.

Fall 2018 **Visiting Scholar**
Institute for Computational and Experimental Research in Mathematics. Providence, RI.
during a semester-long program on *Nonlinear Algebra*

Fall 2014 **Visiting Scholar**
Simons Institute for the Theory of Computing. U.C. Berkeley.
during a semester-long program on *Algorithms and Complexity in Algebraic Geometry*

2013 – 2017 **Graduate Student**
Texas A&M University. Department of Mathematics.

Organization

from June 2021 **Nonlinear Algebra Seminar**
Max Planck Institute for Mathematics in the Sciences.
Co-organizers: B. Sturmfels, S. Telen

August 2021 **SIAM Minisymposium: Tensor Networks and Geometry**
SIAM Conference on Applied Algebraic Geometry.
Co-organizers: M. Christandl, D. Stilck-França, A. H. Werner

June 2018 **QMath Masterclass - Tensors: Geometry and Quantum Information**
University of Copenhagen and Niels Bohr International Academy.
Co-organizers: S. Andersen, M. Christandl, A. H. Werner

Teaching experience

2021 **PostDoc**
Max Planck Institute for Mathematics in the Sciences.
Designing and lecturing for the course Introduction to Enumerative Geometry
`https://sites.google.com/view/intro-enumerative-geometry/`

2017 – 2020 **PostDoc**
University of Copenhagen. Department of Mathematics.
Teaching assistant for Complex Analysis II, Spring 2019 and Fall 2019

2013 – 2017 **Teaching Assistant**
Texas A&M University. Department of Mathematics.
Teaching assistant experience in several topics in Mathematics:
Help Sessions in Linear Algebra (Spring 2013)
Recitations in Calculus 1 (Fall 2013)
Help Sessions in Linear Algebra (Spring 2014)
Grader for History of Math (Fall 2014)
Recitations in Calculus 2 (Spring 2015)
Grader for Cryptography (Spring 2016 - Fall 2016)

Outreach

2017 **Kulturnatten**
University of Copenhagen.
Collaboration in the event organized by QMATH on *cake cutting with straight edge and compass.*

2015 **Pi Day of the Century**
Texas A&M University.
Outreach event geared towards elementary, middle and high school students,
in collaboration with Texas A&M Math Circle.

2008 – 2012 **Gara matematica (Mathematics Contest)**
Dipartimento di Matematica Ulisse Dini, Florence.
Collaboration in proctoring and grading in an annual contest for high school students.

Publications

1 **The Geometry of Discotopes**. (w/C. Meroni)
preprint `arXiv:2111.01241`.

2 **Algebraic Compressed Sensing**. (w/P. Breiding, M. Michałek, N. Vannieuwenhoven)
preprint `arXiv:2108.13208`.

3 **Optimization at the boundary of the tensor network variety**. (w/M. Christandl, D. Stilck França, A. Werner)
Phys. Rev. B 103 (19), 195139, (2021), `doi:10.1103/PhysRevB.103.195139`.

4 **The Degree of Stiefel Manifolds**. (w/T. Brysiewicz)
Enumerative Combinatorics and Applications, vol. 1(3), n. S2R20, (2021).

5 **Border rank non-additivity for higher order tensors**. (w/M. Christandl, M. Michałek, J. Zuiddam)
SIAM J. Matrix Anal. Appl., 42(2), 503–527, (2021), `doi:10.1137/20M1357366`.

6 **Geometric conditions for strict submultiplicativity of rank and border rank**. (w/E. Ballico, A. Bernardi, E. Ventura, A. Oneto)
Ann. Mat. Pura ed Appl. vol. 200, 187–210, (2021), doi:10.1007/s10231-020-00991-6.

7 **Towards a Geometric Approach to Strassen's Asymptotic Rank Conjecture**. (with A. Conner, J. M. Landsberg, E. Ventura, Y. Wang)
Collectanea Math. vol. 72, 63–86, (2021), doi:10.1007/s13348-020-00280-8.

8 **Dimension of Tensor Network Varieties**. (w/A. Bernardi, C. De Lazzari)
preprint arXiv:2101.03148, 2021.

9 **SARS-CoV-2 transmission routes from genetic data: a Danish case study**. (w/A. Bluhm, M. Christandl, F. R. Klausen, L. Mancinska, V. Steffan, D. Stilck França, A. Werner)
PLOS ONE 15 (10), e0241405, 2020, doi:10.1371/journal.pone.0241405.

10 **Kronecker powers of tensors and Strassen's laser method**. (w/A. Conner, J. M. Landsberg, E. Ventura)
ITCS 2020, Leibniz International Proceedings in Informatics (LIPIcs), 151, 10:1–10:28 (2020), doi:10.4230/LIPIcs.ITCS.2020.10.

11 **Partially symmetric versions of Comon's problem via simultaneous rank**. (w/A. Oneto, E. Ventura)
SIAM J. Matrix Anal. Appl., 40(4), 1453–1477, (2019), doi:10.1137/18M1225422.

12 **Tensors with maximal symmetries**. (w/A. Conner, J. M. Landsberg, E. Ventura)
preprint arXiv:1909.09518, 2019.

13 **Explicit polynomial sequences with maximal spaces of partial derivatives and a question of K. Mulmuley**. (w/J.M. Landsberg)
Theory of Computing 15(3), 1–24, (2019), doi:10.4086/toc.2019.v015a003.

14 **Border Waring Rank via Asymptotic Rank**. (w/M. Christandl, A. Oneto)
preprint arXiv:1907.03487, 2019.

15 **Border rank is not multiplicative under the tensor product**. (w/M. Christandl, A. K. Jensen)
SIAM J. Appl. Alg. Geom (SIAGA), Vol. 3 (2), 231–255 (2019), doi:10.1137/18M1174829.

16 **On the partially symmetric rank of tensor product of W-states and other symmetric tensors**. (w/E. Ballico, A. Bernardi, M. Christandl)
Rend. Lincei Mat. Appl. 30, 93–124 (2019), doi:10.4171/RLM/837.

17 **A note on the cactus rank for Segre-Veronese varieties**. (w/E. Ballico, A. Bernardi)
J. Algebra Vol. 526, pp. 6-11 (2019), doi:10.1016/j.jalgebra.2019.01.027.

18 **Matrix Product States and the Quantum max-flow/min-cut conjectures**. (w/J. M. Landsberg, M. Walter)
J. Math. Phys, Vol. 59 (10), 102205 (2018), doi:10.1063/1.5026985.

19 **Geometric Complexity Theory and matrix powering**. (w/C. Ikenmeyer, G. Panova)
Diff. Geom. and Appl., Vol. 55, 106–127 (2017), doi:10.1016/j.difgeo.2017.07.001.

20 **Geometric Aspects of Iterated Matrix Multiplication**
J. Algebra Vol. 461, pp.42–64, (2016), doi:10.1016/j.jalgebra.2016.04.028.

21 **Complexity of linear circuits and geometry**. (w/J. Hauenstein, C. Ikenmeyer, J. M. Landsberg)
FOCM, Vol. 16 (3), 599–635, (2016), doi:10.1007/s10208-015-9258-8.

22 **An asymptotic bound for secant varieties of Segre varieties**
Ann. Univ. Ferrara, Vol.59 (2), 285-302, (2013), doi:10.1007/s11565-013-0175-y.

Selected seminars and Posters

Oct. 2021 **Geometry of Tensor Networks**
Séminaire Calcul Formel. Université de Limoges.

Aug. 2021 **Geometry of Direct Sums and Kronecker Powers of Tensors**
SIAM Conf. Applied Algebraic Geometry (SIAM AG21). Texas A&M University - College Station, TX.

April 2021 **Geometry of Tensor Network Varieties**
Algebra and Geometry Seminar. Universitá degli Studi di Trieste.

March 2021 **Border rank under direct sum: from Schönhage to tensor networks**
Quantum Information, Algebra and Geometry Seminar. Università degli Studi di Trento.

Dec. 2020 **Varieties of sums of powers, Stiefel manifolds and their degrees**
Algorithmic Mathematics and Complexity Theory Seminar. TU Berlin.

Nov. 2020 **Segre reembedding of secant varieties and multiplicativity of rank and border rank**
Real Algebraic Geometry Seminar. University of Konstanz.

Oct. 2020 **Approaching the boundary of tensor network varieties**
Geometry Seminar. Texas A&M University - College Station, TX.

March 2020 **Border rank and tensor product: geometry and complexity**
Nonlinear Algebra Seminar Online. Organized by Max Planck Institute - Leipzig.

Sept. 2019 **Tensors, Symmetries and Matrix Multiplication**
Congresso UMI 2019. Università di Pavia - Italy.

Jul. 2019 **Rank, border rank, multiplicativity and entanglement**
SIAM Conf. Applied Algebraic Geometry (SIAM AG19). University of Bern - Switzerland.

Jan. 2019 **Tensors with Symmetries and Matrix Multiplication**
Workshop on Theoretical Computer Science and Algebraic Geometry. Max Planck Institute for Informatics - Saarbrücken - Germany.

Nov. 2018 **Rank of Forms and Partial Derivatives**
Geometry Seminar. Texas A&M University - College Station, TX.

Sept. 2018 **Barriers for Geometric Methods in Complexity Theory**
UMI-SIMAI-PTM Joint Meeting. Wrocłow - Poland.

Tensors with Symmetries and Matrix Multiplication
Workshop: Tensors. Politecnico di Torino - Turin.

July 2018 **SLOCC transformations, tensor restriction and Strassen's asymptotic rank conjecture**
Quantum Information, Algebra and Geometry Seminar. Università degli Studi di Trento.

April 2018 **Cactus rank and multihomogeneous polynomials**
Geometry Seminar. Texas A&M University - College Station, TX.

Feb. 2018 **Multiplicativity of rank and border rank**
Seminario di Geometria. Dipartimento di Matematica e Informatica Ulisse Dini - Firenze.

Sept. 2017 **On multiplicativity of various notions of rank**
Geometry seminar. Texas A&M University - College Station, TX.

Jan. 2017 **Rigidità di matrici e complessità del prodotto matrice-vettore**
Seminario di Geometria. Dipartimento di Matematica e Informatica Ulisse Dini - Firenze.

Geometric Complexity Theory and matrix powering. TU Berlin.

Geometry and complexity of matrix-vector multiplication
Workshop on Non-linear Algebra. Max Planck Institute for Mathematics in the Sciences - Leipzig.

July 2016 **Matrix Rigidity and the Complexity of Performing a Linear Map**
DGA: Differential Geometry and Applications Conference. Masaryk University - Brno.

May 2016 **Geometry of Small Matrix Multiplication**
Workshop on Software and Applications in Numerical A.G.. University of Notre Dame.

Nov. 2014 **The Geometry of Iterated Matrix Multiplication**
Computational Algebraic Geometry Seminar. UC Berkeley.

Last update: November 4, 2021.