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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)

Grants and 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*)
Master's Thesis Award, March 11th, 2013 - Florence, Italy

Fellowships

Fall 2022 *Simons Junior Leader*
Institute of Mathematics of the Polish Academy of Sciences, Warsaw, Poland
Duration: Six weeks

Fall 2018 *Visiting Scholar*
at Institute for Computational and Experimental Research in Mathematics, Providence, RI
Duration: Three months

Summer 2018 *Visiting Researcher*
in the Research in Pairs program at CIRM Trento, Italy
Duration: Four weeks

Work experience

2023 – **Chaire Professeur Junior**, *Institut de Mathématiques de Toulouse*, Université Toulouse III - Paul Sabatier.

2022 – 2023 **PostDoc**, *University of Saarland, Saarbrücken*, Dept. of Mathematics and Computer Science.

Fall 2022 **Simons Junior Leader**, *Institute of Mathematics of the Polish Academy of Sciences*, Warsaw.
during the AGATES semester on *Algebraic Geometry with Applications to TEnsors and Secants*

2020 – 2022 **PostDoc**, *Max Planck Institute for Mathematics in the Sciences*, Leipzig.

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

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

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

August 2023 **SIAM Minisymposium: Tensors in Algebraic Geometry**, SIAM Conference on Applied Algebraic Geometry.
Co-organizers: Alessandro Oneto, Luca Sodomaco, Neriman Tokcan

Sept 2022 - Nov. 2022 **Events within the Thematic Semester AGATES**, Institute of Mathematics of the Polish Academy of Sciences – Warsaw.
Summer School on the Geometry of Tensors – Co-organizers: F. Galuppi, J. Jelisiejew
Kickoff Workshop – Co-organizers: F. Galuppi, J. Jelisiejew
Workshop in Algebraic Geometry and Complexity Theory – Co-organizers: W. Buczyńska, N. Vannieuwenhoven

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

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

Teaching experience

2023 **PostDoc**, *Saarland University*, Department of Computer Science.
Teaching assistant for Quantum Computing, Spring 2023

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/`

2019 **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 four several undergraduate courses in Mathematics:
Help Sessions in Linear Algebra (Spring 2013)
Recitations in Calculus 1 (Fall 2013)
Help Sessions in Linear Algebra (Spring 2014)
Recitations in Calculus 2 (Spring 2015)
Grader for Cryptography (Spring 2016 - Fall 2016)

Mentorship

Leonie Kayser, *2023 – (current)*, MPI-MiS, Leipzig.
I serve as a *mentor*. In this capacity, I am actively involved in guiding the student's research and providing assistance in their mathematical development alongside their advisor.

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 **A Gap in the Subrank of Tensors**, (w/M. Christandl, J. Zuiddam), to appear SIAM J. Appl. Geom. Alg (SIAGA), 2023.

2 **Decompositions and Terracini loci of cubic forms of low rank**, (w/L. Chiantini), to appear in Deformation of Artinian Algebras and Jordan Types, CONM, 2023.

3 **Geometry of Tensors: Open problems and research directions**, A report on the AGATES Kickoff Workshop, 2023.

4 **Algebraic Compressed Sensing**, (w/P. Breiding, M. Michałek, N. Vannieuwenhoven), Appl. Comp. Harm. An., 65, 374–406, 2023.

5 **Dimension of Tensor Network Varieties**, (w/A. Bernardi, C. De Lazzari), Comm. Cont. Math., 25(10), 2250059, 2023, doi:10.1142/S0219199722500596.

6 **Degree-restricted strength decompositions and algebraic branching programs**, (w/P. Ghosal, C. Ikenmeyer, V. Lysikov), FSTTCS 2022 - Leibniz International Proceedings in Informatics (LIPIcs), 250, 20:1-20:15, 2022, doi:10.4230/LIPIcs.FSTTCS.2022.20.

7 **The Geometry of Discotopes**, (w/C. Meroni), Le Matematiche 77 (1), 2022, doi:10.4418/2022.77.1.8.

8 **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.

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

10 **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.

11 **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.

12 **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.

13 **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.

14 **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.

15 **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.

16 **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.

17 **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.

18 **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.

19 **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.

20 **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.

21 **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.

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

23 **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.

24 **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.

Preprints

1 **Quatroids and Rational Plane Cubics**, (w/T. Brysiewicz, A. Steiner), preprint arXiv:2309.07357, 2023.

2 **Characteristic polynomials and eigenvalues of tensors**, (w/F. Galuppi, E. Turatti, L. Venturello), preprint arXiv:2308.10957, 2023.

3 **The next gap in the subrank of 3-tensors**, (w/J. Zuiddam), preprint arXiv:2307.06115, 2023.

4 **Hilbert Functions of Chopped Ideals**, (w/L. Kayser, S. Telen), preprint arXiv:2307.02560, 2023.

5 **Partial Degeneration of Tensors**, (w/M. Christandl, V. Lysikov, V. Steffan), preprint arXiv:2212.14095, 2022.

6 **Quantum max-flow in the bridge graph**, (w/V. Lysikov, V. Steffan), preprint arXiv:2212.09794, 2022.

7 **Border complexity via elementary symmetric polynomials**, (w/P. Dutta, C. Ikenmeyer, G. Jindal, V. Lysikov), preprint arXiv:2211.07055, 2022.

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

Selected Seminars

July 2023 **A Gap in the Subrank of Tensors**, *SIAM Conf. Applied Algebraic Geometry (SIAM AG23)*, TU Eindhoven, NL.

May 2023 **Rank algorithms, Hilbert functions and non-saturated ideals**, *Workshop Cactus v. Secants*, Toulouse Mathematics Institute.

April 2023 **Tensor subrank and the geometry of small orbits**, *Seminario di Algebra, Geometria Algebrica e Applicazioni*, UniTo-PoliTO, Torino.

March 2023 **Border rank and homogeneous complexity classes**, *7th Workshop on Algebraic Complexity Theory (WACT 2023)*, U. Warwick.

Nov. 2022 **Optimization on Tensor Network Varieties**, *AGATES Workshop on Tensors in statistics, optimization and machine learning*, IMPAN – Warsaw.

July 2022 **Lower bounds for algebraic branching programs via intersection theory**, *Applied Algebraic Geometry Seminar*, Dipartimento di Matematica e Informatica Ulisse Dini - Firenze.

April 2022 **Tensor subrank and homomorphism duality**, *Workshop on geometry and complexity theory*, Toulouse Mathematics Institute.

Dec. 2021 **Optimization on Tensor Network Varieties**, *Workshop on Optimization Under Symmetry*, Simons Institute - Berkeley.

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*, Max Planck Institute for Math. in the Sciences - 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.

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

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.

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 10, 2023.