Fulvio Gesmundo

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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: Dr. Donato Pertici.
Graduation: April 2010.
Thesis: Spazi Completamente Regolari e Compattificazione di Stone-Čech
        (Completely Regular Spaces and Stone-Čech Compactification)

Grants and Awards

Nov. 2023 – · *ANR-CPJ Starting Package*
Funding for a period of three years (200k euro).

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 de Toulouse.
2022 – 2023	**PostDoc**, *University of Saarland, Saarbrücken*, Dept. of Mathematics and Computer Science.
2020 – 2022	**PostDoc**, *Max Planck Institute for Mathematics in the Sciences*, Leipzig.
2017 – 2020	**PostDoc**, *University of Copenhagen*, QMATH – Dept. of Mathematical Sciences.
2013 – 2017	**Graduate Student**, *Texas A&M University*, Department of Mathematics.

VISITING POSITIONS

Fall 2022	**Simons Junior Leader**, *Institute of Mathematics of the Polish Academy of Sciences*, Warsaw.
during a semester-long program on *Algebraic Geometry with Applications to Tensors and Secants*
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*

Teaching experience

2024 –	**Junior Professor**, *Université de Toulouse*, Institut de Mathématiques.
Teaching assistant for Geometry and Algebra, Spring 2024
Lecturer and teaching assistant for Geometry and Algebra, Spring 2025
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

Postdocs

Chia-Yu Chang, *Oct. 2024 – (current)*, Institut de Mathématiques de Toulouse.

PhD Students

Leonie Kayser, *Jan. 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.

Interns

Taddeo Rocq, *Summer 2024*, ENS Lyon.
Intern at Institut de Mathématiques de Toulouse for a 6 weeks

Aryan Kusre, *Summer 2024*, Chennai Mathematical Institute.
Intern at Institut de Mathématiques de Toulouse for a 10 weeks

Organization

May 2024	**JM Invariant at 60: A Conference on Tensor Invariants in Geometry and Complexity Theory**, Auburn University. Co-organizers: Austin Conner, Cameron Farnsworth, Frederic Holweck, Luke Oeding
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

Oct. 2024 - (current)	**Maths-Info Seminar**, Institut de Mathématiques de Toulouse. Co-organizers: C. Hardouin, P. Moustrou, M. Sablik, M. Skomra
June 2021 - Dec. 2021	**Nonlinear Algebra Seminar**, Max Planck Institute for Mathematics in the Sciences. Co-organizers: B. Sturmfels, S. Telen

Outreach

2019	**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)**, Dipart. di Matematica Ulisse Dini, Florence. Collaboration in proctoring and grading in an annual contest for high school students.

Publications

1. **Algebraic metacomplexity and representation theory**, (w/ M. van den Berg, P. Dutta, C. Ikenmeyer, V. Lysikov), 40th Comp. Compl. Conf. (CCC 2025), vol. 339, pp. 26:1–26:35, (2025) `doi:10.4230/LIPIcs.CCC.2025.26`.

2. **Geometric complexity theory for product-plus-power**, (w/P. Dutta, C. Ikenmeyer, G. Jindal, V. Lysikov), J. Symb. Computation, 131, 102458, 2025, `doi:10.1016/j.jsc.2025.102458`.

3. **The next gap in the subrank of 3-tensors**, (w/J. Zuiddam), Lin. Alg. Appl., vol. 722, pp.1-11, 2025, `doi:10.1016/j.laa.2025.04.027`.

4. **Linear preservers of secant varieties and other varieties of tensors**, (w/B. Lovitz, Y. Han), J. Symb. Computation, 131, 102449, 2025, `doi:10.1016/j.jsc.2025.102449`.

5. **Bernstein-Gelfand-Gelfand meets geometric complexity theory: resolving the 2×2 permanents of a $2 \times n$ matrix**, (w/A. Huang, H. Schenck, J. Weyman), Trans. Amer. Math. Soc., vol. 378(5), pp. 3573-3596, 2025, `doi:10.1090/tran/9376`.

6. **Collineation varieties of tensors**, (w/H. Keneshlou), Collectanea Math., online first, 2025, `doi:10.1007/s13348-025-00467-x`.

7. **Hilbert Functions of Chopped Ideals**, (w/L. Kayser, S. Telen), J. Algebra 666, pp. 415-445, 2025, `doi:10.1007/s13366-024-00776-5`.

8   **Quatroids and Rational Plane Cubics**, (w/T. Brysiewicz, A. Steiner), Beiträge Alg. Geom., 65(4), pp. 923–972 2024, `doi:10.1007/s13366-024-00776-5`.

9   **Quantum max-flow in the bridge graph**, (w/V. Lysikov, V. Steffan), Transformation Groups, online first, 2024, `doi:10.1007/s00031-024-09863-2`.

10 **Fixed-parameter debordering of Waring rank**, (w/P. Dutta, C. Ikenmeyer, G. Jindal, V. Lysikov), STACS 2024, Leibniz Int. Proc. Inf. (LIPIcs), 289, pp. 30:1-30:15, 2024, `doi:10.4230/LIPIcs.STACS.2024.30`.

11 **Homogeneous Algebraic Complexity Theory and Algebraic Formulas**, (w/P. Dutta, C. Ikenmeyer, G. Jindal, V. Lysikov), ITCS 2024, Leibniz Int. Proc. Inf. (LIPIcs), 287, pp. 43:1-43:23 2024, `doi:10.4230/LIPIcs.ITCS.2024.43`.

12 **Decompositions and Terracini loci of cubic forms of low rank**, (w/L. Chiantini), Deformation of Artinian Algebras and Jordan Types, CONM, vol 805, pp. 139–156, 2024, `doi:10.1090/conm/805/16131`.

13 **Partial Degeneration of Tensors**, (w/M. Christandl, V. Lysikov, V. Steffan), SIAM J. Mat. An. (SIMAX), 45(1), pp. 771–800, 2024, `doi:10.1137/23M1554898`.

14 **A Gap in the Subrank of Tensors**, (w/M. Christandl, J. Zuiddam), SIAM J. Appl. Geom. Alg (SIAGA), vol. 7 (4), pp. 742–76, 2023, `doi:10.1137/22M154327`.

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

16 **Algebraic Compressed Sensing**, (w/P. Breiding, M. Michałek, N. Vannieuwenhoven), Appl. Comp. Harm. An., 65, 374–406, 2023, `doi:10.1016/j.acha.2023.03.006`.

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

18 **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`.

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

20 **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`.

21 **The Degree of Stiefel Manifolds**, (w/T. Brysiewicz), Enumerative Combinatorics and Applications, vol. 1(3), n. S2R20, 2021, `doi:10.54550/ECA2021V1S3R20`.

22 **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`.

23 **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`.

24 **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`.

25 **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`.

26 **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`.

27 **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`.

28 **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`.

29 **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`.

30 **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`.

31 **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`.

32 **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`.

33 **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`.

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

35 **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`.

36 **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 **Waring decompositions of special binomials**, (w/L. Chiantini, S. Marziali), `arXiv:2512.13805`, 2025.

2 **Polynomials of small slice rank and strength**, (w/C. Flavi, A. Oneto, E. Ventura), `arXiv:2509.12322`, 2025.

3 **Identifiability through special linear measurements**, (w/A. Grosdos, A. Uschmajew), `arXiv:2505.24328`, 2025.

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

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

Selected Seminars

HIGHLIGHTS

July 2025 **Boundary components of orbit-closures**, *INABAG Conference*, Trento, IT.

July 2024 **Geometry and asymptotics in the study of tensors**, *MEGA 2024*, Leipzig - Germany.

May 2024 **Algebraic Geometry and Complexity Theory**, *Mathematical Colloquium*, Bern - Switzerland.

Dec. 2023 **Geometric methods for lower bounds in complexity theory**, *IRIT Scientific Day*, Toulouse, FR.

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

OTHER INVITED SEMINARS

July 2025 **Boundary components of orbit-closures**, *INABAG Conference*, Trento, IT.

April 2025 **Tensor networks, equations and geometry**, *Geometry Seminar*, TU Dresden, Germany.

March 2025 **Apolarity theory, zero-dimensional schemes and their role in complexity theory**, *Workshop in Algebraic Complexity, Geometry, and Representations*, Warwick, UK.

Dec. 2024 **Geometry of Tensor Networks**, *Journée LPT-IMT*, Toulouse.

Nov. 2024 **Geometric Methods in Complexity Theory**, *Quantum Information Colloquium*, Bochum - Germany.

Sept. 2024 **Subrank of tensors in geometry and invariant theory**, *Sém. Méd. Géom. Alg.*, Genova - Italy.

May 2024 **Collineation varieties of tensors**, *Geometry Seminar*, Texas A&M University - College Station, TX.

Oct. 2023 **Characteristic polynomials of tensors**, *Nonlinear Algebra Seminar*, MPI Leipzig, DE.

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.
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*, Wrocław - 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.
Jan. 2017	**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.