Elena Giorgi

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Department of Mathematics 606, Columbia University, New York NY

(updated March 2025)

Research interests

General Relativity, Hyperbolic PDEs, Differential Geometry

Academic appointments

Columbia University — New York, NY
Assistant Professor, Department of Mathematics — *July 2021 – present*

Princeton University — Princeton, NJ
Postdoctoral Research Associate, Gravity Initiative — *Sept. 2019 – June 2021*

Education

Columbia University — New York, NY
Ph.D. in Mathematics — *Sept. 2015 – May 2019*
Thesis: "The linear stability of Reissner-Nordström spacetime for small charge"
Advisors: Mu-Tao Wang (Columbia University), Sergiu Klainerman (Princeton University)

Ecole Normale Supérieure de Lyon — Lyon, France
M.Sc. in Mathematical Physics (M2). Advisor: Abdelghani Zeghib — *Sept. 2014 – July 2015*

Université Paris Sud — Orsay, France
M.Sc. in Mathematics (M1). Advisor: Jacques Smulevici — *Sept. 2013 – July 2014*

Università di Pisa — Pisa, Italy
B.Sc. in Mathematics. Advisor: Bruno Martelli — *Sept. 2010 – July 2013*

Grants and Awards

2024 Sloan Research Fellowship
Sloan Foundation, $75,000 — *2024 – 2026*

NSF CAREER Grant DMS-2336118
"Gravitational and Electromagnetic Waves on Black Holes", $454,261 — *2024 – 2029*

Frontiers of Science Award (previously known as Best Paper Award) in General Relativity
International Congress of Basic Science, Beijing, $25,000.00 — *2023*

NSF Grant DMS-2306143
"Physical-space estimates on black hole perturbations", $223,924.00 — *2023 – 2026*

Simons Junior Faculty Fellows Award # 825870
Columbia University, Simons Foundation — *2021 – 2024*

NSF Grant DMS-2006741, transferred to DMS-2128386
"The mathematical theory of black holes with matter", $119,623.00 — *2020 – 2023*

American Mathematical Society (AMS) Simons Travel Grant
American Mathematical Society, declined after receiving NSF grant, $5000.00 — *2020*

Association Women in Mathematics (AWM) Dissertation Prize 2020
Association Women in Mathematics, $500.00 — *2020*

Graduate Student Teaching Award
Department of Mathematics, Columbia University, $2,500.00 — *2018 – 2019*

Peter and Catherine Klein Fellowship
Department of Mathematics, Columbia University — *2017 – 2018*

Master scholarship Labex Milyon
Ecole Normale Superieure de Lyon, €10,000.00 — *2014 – 2015*

Master scholarship Fondation Jacques Hadamard
Université Paris Sud, €10,000.00 — *2013 – 2014*

INDAM Undergraduate scholarship
Istituto Nazionale di Alta Matematica, €12,000.00 — *2010 – 2013*

Publications

1. **Boundedness and Decay for the Teukolsky System in Kerr-Newman Spacetime II: The Case $|a| \ll M, |Q| < M$ in axial symmetry**

   Elena Giorgi, Jingbo Wan, to appear in *Advances in Theoretical and Mathematical Physics*, 23 pages

2. **Physical-space estimates for axisymmetric waves on extremal Kerr spacetime**

   Elena Giorgi, Jingbo Wan, *Journal of Functional Analysis, Vol. 287, Issue 12, 110668 (2024)*, 29 pages

3. **The Carter tensor and the physical-space analysis in perturbations of Kerr-Newman spacetime**

   Elena Giorgi, *Journal of Differential Geometry, Vol. 127, No. 1, pp. 277-371 (2024)*, 95 pages

4. **Electromagnetic-gravitational perturbations of Kerr-Newman spacetime: the Teukolsky and Regge-Wheeler equations**

   Elena Giorgi, *Journal of Hyperbolic Differential Equations, Vol. 19, No. 01, pp. 1-139 (2022)*, 139 pages

5. **Numerical computation of second order vacuum perturbations of Kerr black holes**

   Justin L. Ripley, Nicholas Loutrel, Elena Giorgi, Frans Pretorius, *Physical Review D 103, 104018 (2021)*, 29 pages

6. **Second order perturbations of Kerr black holes: Formalism and reconstruction of the first order metric**

   Nicholas Loutrel, Justin L. Ripley, Elena Giorgi, Frans Pretorius, *Physical Review D 103, 104017 (2021)*, 19 pages

7. **The linear stability of Reissner-Nordström spacetime: the full subextremal range**

   Elena Giorgi, *Communications in Mathematical Physics, 380, 1313–1360 (2020)*, 48 pages

8. **The linear stability of Reissner-Nordström spacetime for small charge**

   Elena Giorgi, *Annals of PDE, 6, 8 (2020)*, 145 pages

9. **Boundedness and decay for the Teukolsky system of spin ± 2 on Reissner-Nordström spacetime: the case $|Q| \ll M$**

   Elena Giorgi, *Annals Henri Poincaré, 21, 2485 - 2580 (2020)*, 96 pages

10. **Coupled gravitational and electromagnetic perturbations of Reissner-Nordström spacetime in a polarized setting**

    Elena Giorgi, *Advances in Theoretical and Mathematical Physics, 24, 4, 979 - 1025 (2020)*, 46 pages

11. **Boundedness and decay for the Teukolsky equation of spin ± 1 on Reissner-Nordström spacetime: the $\ell = 1$ spherical mode**

    Elena Giorgi, *Classical Quantum Gravity, 36, 205001 (2019)*, 48 pages

12. **On the local extension of Killing vector fields in electrovacuum spacetimes**

    Elena Giorgi, *Annales Henri Poincaré, 20, 2271 - 2293 (2019)*, 23 pages

Research monographs

13. **Wave equation estimates and the nonlinear stability of slowly rotating Kerr black holes**

    Elena Giorgi, Sergiu Klainerman, Jérémie Szeftel, *Pure and Applied Mathematics Quarterly, Vol. 20, Issue 7 (2024), pp. 2865-3849*, 985 pages

Preprints

14. **Boundedness and Decay for the Teukolsky System in Kerr-Newman Spacetime I: The Case $|a|, |Q| \ll M$**

    Elena Giorgi, *preprint arXiv:2311.07408*, 109 pages

15. **A general formalism for the stability of Kerr**

    Elena Giorgi, Sergiu Klainerman, Jérémie Szeftel, *preprint arXiv:2002.02740*, 139 pages

Expository surveys

16. **Electromagnetic-gravitational perturbations of Kerr-Newman black hole**

    Elena Giorgi, *International Journal of Modern Physics D (2025) 2540003*

17. **Decay for the Teukolsky system in Kerr-Newman**

    Elena Giorgi, *Mathematisches Forschungsinstitut Oberwolfach, Report No. 36 (2024), 17–21*

18. **Recent progress on the stability of charged black holes**

    Elena Giorgi, *Proceedings of the International Congress of Basic Science (2024)*

19. **The Mathematics of Stable Black Holes**

    Elena Giorgi, *Notices of the AMS, Vol. 70, Number 4, 552–563 (2023)* (also translated in Chinese for *Mathematical Advances in Translation*)

20. **Stable black holes: in vacuum and beyond**

    Elena Giorgi, *Bull. Amer. Math. Soc., Vol. 60, Number 1, 1–27 (2023)*

21. **The stability of black holes with matter**

    Elena Giorgi, *Current Events Bulletin Booklet, American Mathematical Society (2022)*

22. **The stability of charged black holes**

    Elena Giorgi, *Mathematisches Forschungsinstitut Oberwolfach, Report No. 40 (2021), 43–46*

Career advice

23. **Don't give a terrible talk**

    Elena Giorgi, *Notices of the AMS, Early Career Section (January 2023)*

Invited Colloquia

- **Department Colloquium**, Temple University, April 2025
- **Department Colloquium**, Stony Brook University, Feb. 2024
- **Nottingham Centre of Gravity**, University of Nottingham, May 2023
- **Joint Online Mathematical Relativity Colloquium (JoMaReC)**, virtual, Dec. 2022
- **Public Lecture at the virtual International Congress of Mathematics**, IMU, July 2022
- **Current Events Bulletin, Joint Mathematics Meeting**, AMS, Seattle (moved to virtual), Jan. 2022 (postponed to April 2022)
- **Mathematics Department Colloquium**, University of California Berkeley (virtual), Jan. 2021
- **Colloquium Seminar**, Northwestern University (virtual), Jan. 2021
- **Pure Math Seminar**, MIT (virtual), Jan. 2021
- **Analysis/PDE Seminar**, UCLA (virtual), Jan. 2021
- **Special Department Colloquium**, Columbia University (virtual), Jan. 2021
- **Department Colloquium**, Stony Brook University (virtual), Jan. 2021
- **Special Colloquium**, Rutgers University (virtual), Nov. 2020
- **Department Colloquium**, Brown University (virtual), Oct. 2020
- **Colloquium**, Black Hole Initiative, Harvard University, Oct. 2019

Invited Lecture Series

- **Summer School on Geometry and Gravity**, SISSA, Italy, July 2025
- **EWM-EMS Summer School "The Cauchy problem in General Relativity"**, Institut Mittag Leffler, Sweden, June 2022

Invited Conference Talks

- **Black holes in General Relativity Conference**, Fields Institute, Toronto, May 2026
- **Partial differential equations at the intersection of gravity, fluids, and waves**, AMS 2025 Fall Southeastern Sectional Meeting, Tulane University, Oct. 2025
- **Plenary Speaker at 24th International Conference on General Relativity and Gravitation GR24&Amaldi16**, University of Glasgow, July 2025
- **Conference in honor of 80th birthday of Helmut Friedrich**, Mittag-Leffler Institute, June 2025
- **Pacific Northwestern Geometry Seminar**, University British Columbia, May 2025
- **Geometry, Analysis, and Physics in Lorentzian Signature**, Keynote speaker, BIRS Workshop, Granada, May 2025
- **Fifth Duke Mathematics Journal Conference**, Duke University, April 2025
- **Mathematical Aspects of General Relativity**, Oberwolfach Institute, Aug. 2024
- **Plenary Speaker at the 17th Marcel Grossman Meeting**, ICRAnet, Pescara, July 2024
- **Gravitational physics and its mathematical analysis**, Les Diablerets, Switzerland, June 2024
- **Quantum and classical fields interacting with geometry**, Institut Henri Poincare, Paris, April 2024
- **Predictability in General Relativity: celebrating the contributions of Prof. Yvonne Choquet Bruhat**, Raman Research Institute, India (virtual), Feb. 2024
- **Sanya Waves Conference 2024**, Tsinghua Sanya International Mathematics Forum (TSIMF), Jan. 2024
- **Mathematical Relativity: Past, Present, Future**, Vienna, Dec. 2023
- **Workshop on Nonlinear Aspects of General Relativity**, Princeton Gravity Initiative, Oct. 2023
- **9th Conference of the Polish Society on Relativity**, Jagiellonian University (virtual), Sept. 2023
- **Singularity formation in General Relativity and dispersive PDEs**, University of Edinburgh, May 2023
- **Black Hole Initiative Conference**, Harvard University, May 2023
- **Werner Israel Memorial Symposium**, University of Victoria (virtual), May 2023
- **Frontier in Mathematical Science**, Tsinghua-Sanya (hybrid), Dec. 2022
- **2022 International Conference on Geometric Analysis and Hyperbolic Equations**, Guangxi Center for Mathematical Research (virtual), Dec. 2022
- **23rd International Conference on General Relativity and Gravitation**, Institute of Theoretical Physics, Chinese Academy of Sciences, Beijing (virtual), July 2022
- **General Relativity Conference**, Center of Mathematical Sciences and Applications, Harvard University, April 2022
- **Hamiltonian Methods and Asymptotic Dynamics**, ICERM Workshop, Brown University (virtual), Dec. 2021
- **Gravitational Emergence in AdS/CFT Conference**, Banff International Research Station (virtual), Oct. 2021
- **Mathematical aspects of General Relativity**, Oberwolfach Workshop (virtual), Aug. 2021
- **Special session on General Relativity**, Canadian Mathematical Society Summer Meeting (virtual), June 2021
- **Special session on Nonlinear Wave Equations, General Relativity, and Connections to Fluid Dynamics**, AMS Eastern Sectional Meeting (virtual), March 2021
- **Mathematical and Computational Approaches for Solving the Source-Free Einstein Field Equations**, ICERM Workshop, Brown University (virtual), Oct. 2020
- **Mathematical Relativity Conference**, IHP, Paris (cancelled due to COVID-19), June 2020
- **The Geometry and Physics of the Universe Conference**, University of Pittsburgh (cancelled due to COVID-19), March 2020
- **Special session on Wave Phenomena in Fluids and Relativity**, AMS Sectional Meeting, University of Wisconsin in Madison, Sept. 2019
- **Black Hole Initiative Conference**, Harvard University, May 2019
- **Analysis Seminar**, MIT, April 2019
- **Gravity Initiative Inaugural Conference**, Princeton University, March 2019
- **PDE-FRG Conference**, University of Chicago, Oct. 2018
- **Women in PDE Conference**, University of Massachusetts, March 2018

Invited Seminar Talks

- **Analysis & Applied Mathematics Seminar**, Bocconi University, Milan, Dec. 2024
- **Midwest PDE Seminar**, University of Chicago, Sept. 2024
- **CUNY Geometric Analysis Seminar**, City University New York, Feb. 2024
- **London-Oldenburg Relativity Seminar**, University College London/ University of Oldenburg (virtual), July 2023
- **Calderon-Zygmund Analysis Seminar**, University of Chicago (virtual), May 2023
- **Women in Mathematical Relativity**, Leipzig University (virtual), April 2023
- **Gravity group**, Department of Physics, University of Mississippi (virtual), Feb. 2023
- **Geometry, Analysis and Gravitation Seminar**, Queen Mary, University of London (virtual), Feb. 2023
- **Physics Theory Seminar**, Columbia University, Nov. 2022
- **Hyperbolic & Dispersive PDEs Seminar**, Rutgers University, Nov. 2022
- **String/Gravity Theory**, Center for Theoretical Physics, MIT, Oct. 2022
- **PDE and Differential Geometry Seminar**, University of Connecticut (virtual), March 2022
- **General Relativity Colloquium Series**, Center of Mathematical Sciences and Applications, Harvard University (virtual), Nov. 2021
- **PDE Seminar**, Vanderbilt University (virtual), Oct. 2021
- **Analysis and PDE Seminar**, University of California Berkeley (virtual), May 2021
- **Differential Geometry, Mathematical Physics, PDE Seminar**, University of British Columbia (virtual), March 2021
- **Mathematical GR and Hyperbolic PDEs Seminar**, (virtual), Nov. 2020
- **German Austrian Swiss Seminar on Analysis and PDE**, (virtual), Nov. 2020
- **Math-Phys Research Group**, Rutgers University (virtual), Oct. 2020
- **General Relativity Seminar**, Cambridge University (virtual), May 2020
- **Analysis Seminar**, University of Toronto (cancelled due to COVID-19), March 2020
- **Junior Analysis Seminar**, Imperial College, Jan. 2020
- **Gravity Initiative Lunch Talk**, Princeton University, Nov. 2019
- **Mathematical Physics Seminar**, Rutgers University, Nov. 2019
- **PDE Seminar**, Brown University, Nov. 2019
- **Geometric Analysis Seminar**, Rutgers University, Sept. 2019
- **Black Hole Initiative Conference**, Harvard University, May 2019
- **Analysis Seminar**, MIT, April 2019
- **Gravity Initiative Lunch Talk**, Princeton University, Nov. 2018
- **Groups and dynamical systems seminar**, ENS de Lyon, June 2017
- **Mathematical General Relativity Seminar**, Université Pierre et Marie Curie, June 2017

Teaching

Instructor Jan. 2018 – present

Columbia University *New York, NY*

- Spring 2025: Modern Geometry II (Graduate Core Course)
- Fall 2023: Ordinary Differential Equations
- Spring 2023: Partial Differential Equations
- Fall 2021: Ordinary Differential Equations
- Spring 2018: Calculus II
- Summer 2018: Calculus II

Teaching assistant Sept. 2016 – May 2019

Columbia University *New York, NY*

- Calculus I, Calculus III, Partial Differential Equations

Mentoring

Undergraduate Mentoring

Columbia University

- Senior Thesis Fall 2024: "Boundedness Theorem for Non-Degenerate Energy for a Schwarzchild Black Hole", Katherine Mekechuk (Barnard College)
- Supervised Reading Fall 2024 "An introduction to Mathematical General Relativity": Edwina Luo, Owen James Lear
- Supervised Reading Spring 2023 "Physical-space estimates for the wave equation in Kerr-de Sitter": Tuan Dolmen
- Supervised Reading Fall 2022 "Advanced topics in GR and Geometric Analysis": Andrew Isaac Navruzyan
- Supervised Reading Fall 2022 "Application of diffusion equation to neurodegenerative diseases modeling": Maria Stuebner
- Summer 2022 Undergraduate Research "Spherical Harmonics and Black Holes": Tuan Dolmen, Michael Ahenkora, Lucas Martins Barreto Alves

Graduate Mentoring

Columbia University

- Jingbo Wan (co-mentored with Mu-Tao Wang), 2021-2025
- Ethan Hall, 2024–

Postdoctoral Mentoring

Columbia University

- Sam Collingbourne, 2022-2024
- Dawei Shen, 2024–

Organized workshop, conferences or seminars

- **Research group at the Women in Mathematical Physics 3 Workshop**, ICMS, Edinburgh, April 2026
- **Workshop on Extremal Black Holes**, ICERM, Providence, Jan. 2026
- **Hyperbolic & Dispersive Equations on Curved Geometries Workshop**, Simons Center, April 2025
- **Informal Reading Seminar on General Relativity**, Columbia University, Fall 2024 - present
- **Clay Research Workshop Stability and Instability in General Relativity**, Oxford, Sept. 2022
- **General Relativity & Geometric Analysis Seminar and Analysis Seminar**, Columbia University, Fall 2021 - present
- **Monthly General Relativity & Hyperbolic PDEs Seminar (virtual)**, Fall 2020 - present
- **Princeton Gravity Initiative Lunch**, Spring 2021
- **Junior General Relativity Seminar (virtual)**, Summer 2020 - Summer 2021

Service (activities that promote diversity, equity and inclusion are marked with *)

Organizer

*Diversity Lunch Series at Columbia University (funded by the Diversity Matters Award) ** — *Fall 2022 - present*
*ENYGMMa (Empowering New York Gender Minority Mathematicians) Seminar Series ** — *Fall 2022 - present*

Speaker

Informal talk in Astronomy Department, Columbia University — *March 2024*
*AWM & Society of Physics Students, Columbia University ** — *Oct. 2023*
*Women in Mathematical Relativity, Leipzig University (virtual) ** — *April 2023*
*ENYGMMa (Empowering New York Gender Minority Mathematicians) Seminar Series ** — *Nov. 2022*
Michael Zhao Memorial Student Colloquium — *Nov. 2021, Apr. 2023*
Columbia Undergraduate Math Society — *Sept. 2021*
*Women in Science at Columbia Conference ** — *May 2018*

Mentor

*Bridge to the Ph.D. program in STEM ** — *Spring 2023*
*Undergraduate Women in Physics at Princeton University ** — *2019 – 2020*
*Association Women in Mathematics at Columbia University ** — *2016 – 2018*
*Volunteer at Girls' Science Day at Columbia University ** — *Spring 2015*

Faculty Advisor

*Columbia/Barnard Chapter of Association for Women in Mathematics ** — *Fall 2021 – present*

Committee Member

PhD Thesis Defense of Jingbo Wan, Alex Xu (Columbia University) — *Spring 2025*
Frontiers of Science Award in General Relativity — *2025*
Graduate Admission Committee (Columbia University) — *Fall 2022-2024*
*Admission to Bridge to PhD program (Columbia University) ** — *Spring 2024*
PhD Thesis Defense of Chilin Zhang (Columbia University) — *Spring 2024*
Graduate Committee (Columbia University) — *Spring 2023*
PhD Thesis Defense of Mario Apetroaie (University of Toronto) — *Spring 2023*
Ritt Assistant Professor Hiring Committee (Columbia University) — *Fall 2022, Fall 2023*
Roundtable on Columbia Science Vision — *Fall 2022*
Oral Examination of Jingbo Wan, Anthony Coniglio (Columbia University) — *Spring 2022*

Panelist

National Science Foundation — *Ongoing*
*ENYGMMa (Empowering New York Gender Minority Mathematicians) Seminar Series at CUNY ** — *February 2023*

Reviewer

National Science Foundation — *Ongoing*
Natural Sciences and Engineering Research Council of Canada (NSERC) — *2023*

Referee

Annals of PDEs; JDG; Comm. Math. Physics; Ann. Sc. de l'Ecole Norm. Sup.; CQG — *Ongoing*
Reviews in Mathematical Physics; JFA; Letters in Mathematical Physics; JMPA;
Notices of the AMS; PAMQ; Journal of Cosmology and Astroparticle Physics; Mathematical Research Letters

Outreach (activities that promote diversity, equity and inclusion are marked with *)

- Keynote Speaker at May 12: Celebrating Women in Mathematics, "Shedding light on black holes", University of Rome Tor Vergata, June 2025 *
- Guest Speaker at MATHCOUNTS Manhattan (nationwide math competition for middle school students), Feb. 2025
- Organizer of the Sonia Kovalevsky Day for middle school students at Columbia University, Oct. 2023, Oct. 2024 *
- Guest Speaker at "Meet a Scientist: Girls in STEM" at Todholm Public Elementary School in Paisley, Renfrewshire (UK), May 2023 *
- Guest Speaker at "Meet a Scientist" at Scuola d'Italia High School in New York City, April 2023 *
- Public Lecture Speaker at the virtual International Congress of Mathematicians (vICM), July 2022
- Guest Speaker at "STEM Power April Conference" at Dominion High School (VA) (virtual), April 2021 *
- Guest Speaker at "Women in STEM Club" at Davis Senior High School (CA) (virtual), December 2020 *

Press coverage

I am a *Columbia Expert for the Medias*, with expertise in Black Holes and General Relativity.

- Consultant for the Italian translation of "The Gravity of Math" by Steve Nadis and S. T. Yau, October 2024
- "Three Columbia Faculty Members Named Sloan Research Fellows" at *Columbia News*, February 2024
- Interviewed for the article "What is the theory of general relativity?" at *Space.com*, May 2023
- Research featured in the article "Here's a peek into the mathematics of black holes" by Rachel Crowell at *Science News*, March 2023
- Interviewed by *Popular Mechanics*, December 2022
- Research featured in the article "I buchi neri rotanti sono stabili? Intervista con Elena Giorgi" by Roberto Natalini at *MaddMaths! Matematica Divulgazione Didattica*, December 2022

- Research featured in the article "Mathematicians Tied to Princeton Prove Stability of Black Holes" by Julie Bonette at *Princeton Alumni Weekly*, December 2022
- Research featured in the interview "A Researcher Shores Up Einstein's Theory With Math" by Christopher D. Shea at *Columbia News*, October 2022
- Interviewed by *Süddeutsche Zeitung*, September 2022
- Interviewed by *Epsiloon*, August 2022
- Research featured in the article "At Long Last, Mathematical Proof That Black Holes Are Stable" by Steve Nadis at *Quanta Magazine*, August 2022
- Interviewed for the article "Naked Black Holes" by *Sky At Night BBC*, July 2021