Francesco MATTIOTTI

Curriculum vitae et studiorum

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Education

2017–2021 **Ph.D. in Physics**, *University of Notre Dame*, Notre Dame (USA), *cum laude*
Thesis: "Cooperative effects in quantum systems: superradiance and long-range interactions".
Advisors: Prof. Fausto Borgonovi, Prof. Giuseppe Luca Celardo and Prof. Boldizsár Jankó.

2017–2021 **Ph.D. in Science**, *Università Cattolica del Sacro Cuore*, Brescia (Italy), *cum laude*
Thesis: "Cooperative effects in quantum systems: superradiance and long-range interactions".
Advisors: Prof. Fausto Borgonovi, Prof. Giuseppe Luca Celardo and Prof. Boldizsár Jankó.

2013–2016 **Master's degree in Physics**, *Università Cattolica del Sacro Cuore*, Brescia (Italy), *cum laude*
Thesis: "Interplay of cooperativity and noise, from light-harvesting complexes to quantum transport".
Advisor: Prof. Giuseppe Luca Celardo. Co-advisor: Prof. Fausto Borgonovi.

2010–2013 **Bachelor's degree in Physics**, *Università Cattolica del Sacro Cuore*, Brescia (Italy), *cum laude*
Thesis: "Non-Hermitian Hamiltonian approach to quantum transport".
Advisor: Prof. Giuseppe Luca Celardo. Co-advisor: Prof. Giulio Giuseppe Giusteri.

Positions

2021–now **Post-doc**, *University of Strasbourg*, Strasbourg (France)
Quantum Matter Theory group at CESQ - Institut de Science et d'Ingénierie Supramoléculaires.
Group leader: Prof. Guido Pupillo.

2017–2021 **Ph.D. Student with scholarship**, *International Ph.D. in Science*, Brescia (Italy) and Notre Dame (USA)
Joint research project between Università Cattolica del Sacro Cuore and University of Notre Dame (double degree): "Cooperative Effects in quantum systems".
Advisors: Prof. Fausto Borgonovi, Prof. Giuseppe Luca Celardo and Prof. Boldizsár Jankó.

2016 **Research Assistant**, *Università Cattolica del Sacro Cuore*, Brescia (Italy)
Project: "Quantum transport in nanostructured systems with applications to biosystems".
Coordinator: Prof. Fausto Borgonovi.
Funding: Fondazione EULO.

Visiting Positions

02–18/12/2022 **USACH visiting researcher**, *Universidad de Santiago de Chile*, Santiago (Chile)
Scientific collaboration with Prof. Felipe Herrera.

06–13/10/2019 **UC/Sandia visit**, *University of California, Berkeley and Sandia National Laboratories*, Berkeley and Livermore (USA)
Scientific collaboration with Dr. Mohan Sarovar.

09/2018–12/2019 **UND visiting Ph.D. student**, *University of Notre Dame*, Notre Dame (USA)
In the framework of the International Doctoral Program in Science.
Scientific collaboration with Prof. Boldizsár Jankó and Prof. Masaru Kuno.

05/2018–09/2018 **BUAP visiting position**, *Benemérita Universitád Autónoma de Puebla*, Puebla (Mexico)
At Instituto de Física.
Scientific collaboration with Prof. Felix M. Izrailev and Prof. G. Luca Celardo.

16–19/04/2018 **INFN scientific mission**, *Heriot-Watt University*, Edinburgh (United Kingdom)
Scientific collaboration with Prof. Erik Gauger.

08/2017–11/2017 **BUAP visiting position**, *Benemérita Universitád Autónoma de Puebla*, Puebla (Mexico)
At Instituto de Física.
Scientific collaboration with Prof. Felix M. Izrailev and Prof. G. Luca Celardo.

Grants

06/2020–05/2023 **National Science Foundation (NSF), USA**, *NSF DMR1952841*
Title: "Realizing robust superfluorescence from nanocrystal superlattices".
My role: collaborator.
PI: Prof. Masaru Kuno, Co-PI: Prof. Boldizsár Jankó (University of Notre Dame, USA).
Financial Support: 500,877 USD.

2016–2020 **Istituto Nazionale di Fisica Nucleare (INFN), Italy**, *Affiliation with travel grant, DynSysMath project*
Title: "Cooperative effects in quantum systems: superradiance and long-range interactions"
My role: Ph.D. student.
PI: Prof. Fausto Borgonovi (Università Cattolica del Sacro Cuore, Italy).
Financial Support: 6,000 EUR.

22/06/2016 **Fondazione EULO, Italy**, *Title: "Quantum transport in nanostructures devices with application to bio-systems"*
My role: collaborator.
PI: Prof. G. Luca Celardo, Co-PI: Prof. Fausto Borgonovi (Università Cattolica del Sacro Cuore, Italy).
Financial Support: 12,000 EUR.

Awards

13/09/2019 **University of Notre Dame, USA**, *Graduate School Professional Development Award*
Downes Memorial Fund to support a travel to Benemérita Universitád Autónoma de Puebla (Puebla, Mexico) to participate to the QuEBS conference and "Non-Hermitian Quantum Systems" workshop.
Financial Support: 650 USD.

28/05/2019 **University of Notre Dame, USA**, *Graduate School Professional Development Award*
Zahm Research Travel Grant Fund to support a travel to Sandia National Laboratories (Livermore, California) for a scientific collaboration with Mohan Sarovar.
Financial Support: 2,100 USD.

11/07/2013 **Istituto G. Toniolo, Italy**, *Master scholarship*
Financial Support: 3,500 EUR.

Teaching experience

2017 **Teaching Assistant**, *Quantum Mechanics (Bachelor in Physics)*, Università Cattolica del Sacro Cuore, Brescia (Italy)
Teaching duties: 20 hours, exercises.

Transferable skills

Team work and tutoring: I had international collaborations and worked in team with experienced researchers and with other Ph.D. students. I trained and tutored 5 undergraduate and 7 graduate students.

Communication skills: I have given 19 oral presentations, 5 of which invited, and 11 of which to international conferences/gatherings. I have contributed to write 18 scientific papers published on peer-reviewed journals. I have been a referee for 12 scientific papers, as certified by Web of Science.

Language skills

Italian: native speaker.

English: professional working proficiency; *IELTS - Academic score: 7.0/9 (CEFR lev.: C1).*

Spanish: basic proficiency.

French: basic proficiency.

Technical skills

Operating systems: Good knowledge of GNU/Linux and Microsoft Windows environments.

Programming: I use or have used Julia, Python, MATLAB, Mathematica and FORTRAN for scientific computing. I have a basic knowledge of C. I'm familiar with the following libraries: LAPACK, BLAS, Numpy, Matplotlib, Julia QuantumOptics. I do regression testing in my code development.

Software: I use Git for version control. I use LaTeX for scientific typing. I use Microsoft Word/Excel/PowerPoint and LibreOffice. I have used Grace and Gnuplot for data visualization.

References

[18] T. Gupta, G. Masella, F. Mattiotti, N. V. Prokof'ev, and G. Pupillo, Scale-invariant phase transition of disordered bosons in one dimension, Phys. Rev. B **111**, L020503 (2025).

[17] A. Valzelli, A. Boschetti, F. Mattiotti, A. Kargol, C. Green, F. Borgonovi, and G. L. Celardo, Large Scale Simulations of Photosynthetic Antenna Systems: Interplay of Cooperativity and Disorder, J. Phys. Chem. B **128**, 9643–9655 (2024).

[16] S. Kumar, S. Biswas, U. Rashid, K. S. Mony, G. Chandrasekharan, F. Mattiotti, R. M. A. Vergauwe, D. Hagenmuller, V. Kaliginedi, and A. Thomas, Extraordinary Electrical Conductance through Amorphous Nonconducting Polymers under Vibrational Strong Coupling, J. Am. Chem. Soc. **146**, 18999–19008 (2024).

[15] F. S. Lozano-Negro, E. Alvarez Navarro, N. C. Chávez, F. Mattiotti, F. Borgonovi, H. M. Pastawski, and G. L. Celardo, Universal stability of coherently diffusive one-dimensional systems with respect to decoherence, Phys. Rev. A **109**, 042213 (2024).

[14] L. G. Celardo, M. Angeli, F. Mattiotti, and R. Kaiser, Localization of light in three dimensions: A mobility edge in the imaginary axis in non-Hermitian Hamiltonians, EPL **145**, 35002 (2024).

[13] F. Mattiotti, J. Dubail, D. Hagenmüller, J. Schachenmayer, J.-P. Brantut, and G. Pupillo, Multifractality in the interacting disordered Tavis-Cummings model, Phys. Rev. B **109**, 064202 (2024).

[12] N. Sauerwein, F. Orsi, P. Uhrich, S. Bandyopadhyay, F. Mattiotti, T. Cantat-Moltrecht, G. Pupillo, P. Hauke, and J.-P. Brantut, Engineering random spin models with atoms in a high-finesse cavity, Nat. Phys. **19**, 1128–1134 (2023).

[11] A. G. Catalano, F. Mattiotti, J. Dubail, D. Hagenmüller, T. Prosen, F. Franchini, and G. Pupillo, Anomalous Diffusion in the Long-Range Haken-Strobl-Reineker Model, Phys. Rev. Lett. **131**, 053401 (2023).

[10] S. Ghonge, D. Engel, F. Mattiotti, G. L. Celardo, M. Kuno, and B. Jankó, Enhanced robustness and dimensional crossover of superradiance in cuboidal nanocrystal superlattices, Phys. Rev. Res. **5**, 023068 (2023).

[9] F. Mattiotti, M. Sarovar, G. G. Giusteri, F. Borgonovi, and G. L. Celardo, Efficient light harvesting and photon sensing via engineered cooperative effects, New J. Phys. **24**, 013027 (2022).

[8] F. Mattiotti, W. M. Brown, N. Piovella, S. Olivares, E. M. Gauger, and G. L. Celardo, Bio-inspired natural sunlight-pumped lasers, New J. Phys. **23**, 103015 (2021).

[7] N. C. Chávez, F. Mattiotti, J. A. Méndez-Bermúdez, F. Borgonovi, and G. L. Celardo, Disorder-enhanced and disorder-independent transport with long-range hopping: Application to molecular chains in optical cavities, Phys. Rev. Lett. **126**, 153201 (2021).

[6] F. Mattiotti, M. Kuno, F. Borgonovi, B. Jankó, and G. L. Celardo, Thermal decoherence of superradiance in lead halide perovskite nanocrystal superlattices, Nano Lett. **20**, 7382–7388 (2020).

[5] N. C. Chávez, F. Mattiotti, J. A. Méndez-Bermúdez, F. Borgonovi, and G. L. Celardo, Real and imaginary energy gaps: a comparison between single excitation superradiance and superconductivity and robustness to disorder, Eur. Phys. J. B **92**, 144 (2019).

[4] M. Gullì, A. Valzelli, F. Mattiotti, M. Angeli, F. Borgonovi, and G. L. Celardo, Macroscopic coherence as an emergent property in molecular nanotubes, New J. Phys. **21**, 013019 (2019).

[3] F. Borgonovi, F. Mattiotti, and F. M. Izrailev, Temperature of a single chaotic eigenstate, Phys. Rev. E **95**, 042135 (2017).

[2] G. G. Giusteri, F. Mattiotti, and G. L. Celardo, Non-hermitian hamiltonian approach to quantum transport in disordered networks with sinks: Validity and effectiveness, Phys. Rev. B **91**, 094301 (2015).

[1] G. L. Celardo, A. Biella, G. G. Giusteri, F. Mattiotti, Y. Zhang, and L. Kaplan, Superradiance, disorder, and the non-hermitian hamiltonian in open quantum systems, AIP Conf. Proc. **1619**, 64–72 (2014).

Scientific communications

I have given 19 talks, 5 of which invited. I have presented 12 posters at conferences.

28/10/2024 **Poster**, *"JMC 2024" conference*, Marseille (France)
Title: "Multifractality in the interacting disordered Tavis-Cummings model"

27/05/2024 **Poster**, *"E-MRS" conference*, Strasbourg (France)
Title: "Multifractality in the interacting disordered Tavis-Cummings model"

21/05/2024 **Talk**, *"CAFQA" conference*, Ottawa (Canada)
Title: "Strong light-matter coupling in disordered systems: multifractality and protected transport"

07/03/2024 **Talk**, *"APS March Meeting 2024" conference*, Minneapolis (USA)
Title: "Multifractality in the interacting disordered Tavis-Cummings model"

19/01/2024 **Invited Talk**, *Laboratoire de Physique Théorique et Modèles Statistiques – Université Paris-Saclay*, Paris (France)
Title: "Strong light-matter coupling in disordered systems: multifractality and protected transport"

11/01/2024 **Invited Talk**, *Società Italiana di Fisica Statistica Young Seminars*, online
Title: "Strong light-matter coupling in disordered systems: multifractality and protected transport"

16/11/2023 **Invited Talk**, *Laboratoire de Physique des Solides – Université Paris-Saclay*, Paris (France)
Title: "Strong light-matter coupling in disordered systems: multifractality and protected transport"

07/09/2023 **Talk**, *"CMD30 FisMat" conference*, Milan (Italy)
Title: "Multifractality in the interacting disordered Tavis-Cummings model"

06/09/2023 **Invited Talk**, *"CMD30 FisMat" conference*, Milan (Italy)
Title: "Strong light-matter coupling in disordered systems: multifractality and protected transport"

18/07/2023 **Poster**, *"Quantum localization and Glassy physics" school*, Cargèse (France)
Title: "Multifractality in the interacting disordered Tavis-Cummings model"

21/06/2023 **Poster**, *"EGAS 54" conference*, Strasbourg (France)
Title: "Multifractality in the interacting disordered Tavis-Cummings model"

08/03/2023 **Poster**, *"Out-of-equilibrium physics with photons and atoms" school*, Les Houches (France)
Title: "Multifractality in the interacting disordered Tavis-Cummings model"

13/12/2022 **Poster**, *"2nd Workshop on Molecular Quantum Technology - MQT 2022" conference*, Puerto Natales (Chile)
Title: "Multifractality and localization in the disordered interacting Tavis-Cummings model"

13/10/2022 **Talk**, *Institut de Science et d'Ingéniérie Supramoléculaires – University of Strasbourg*, Strasbourg (France)
Title: "Cooperativity in strongly-coupled quantum systems: superradiance, robust transport and multifractality"

16/06/2022 **Invited Talk**, *Laboratoire de Physique et Chimie Théoriques – Université de Lorraine*, Nancy (France)
Title: "Cooperative effects in quantum systems: robustness to disorder and long-range interactions"

25/08/2021 **Talk**, *"17èmes journées de la matière condensée" conference*, online
Title: "Disorder-Enhanced and Disorder-Independent Transport with long range hopping: application to molecular chains in optical cavities"

01/07/2021 **Poster**, *"Wave International Networking Event" conference*, online
Title: "Disorder-Enhanced and Disorder-Independent Transport with Long-Range Hopping: Application to Molecular Chains in Optical Cavities"

25/06/2021 **Poster**, *"I Conference of the Italian Society of Statistical Physics - SIFS" conference*, online
Title: "Disorder-Enhanced and Disorder-Independent Transport with Long-Range Hopping: Application to Molecular Chains in Optical Cavities"

12/03/2021 **Talk**, *"nanoGe Spring Meeting" conference*, online
Title: "Thermal decoherence of superradiance in lead halide perovskite nanocrystal superlattices"

04/09/2020 **Talk**, *"CMD2020GEFES" conference*, online
Title: "Disorder-Enhanced and Disorder-Independent Transport with long range hopping: application to molecular chains in optical cavities"

07/11/2019 **Talk**, *"Non-Hermitian Quantum Systems" conference*, Centro Internacional de Ciencias (Cuernavaca, Morelos, Mexico)
Title: "Interplay of cooperativity and functionality: from light-harvesting nanotubes to efficient photon-sensors"

29/10/2019 **Poster**, *"Quantum Effects in Biological Systems (QuEBS)" conference*, Benemérita Universitád Autónoma de Puebla (Puebla, Mexico)
Title: "Efficient photo-detection and light harvesting via engineered cooperative effects"

29/10/2019 **Talk**, *"Quantum Effects in Biological Systems (QuEBS)" conference*, Benemérita Universitád Autónoma de Puebla (Puebla, Mexico)
Title: "Macroscopic coherence as an emergent property in molecular nanotubes"

23/10/2018 **Talk**, *"Quantum Biology" conference*, Centro Internacional de Ciencias (Cuernavaca, Morelos, Mexico)
Title: "Non-Hermitian Hamiltonian approach to quantum transport in disordered networks with sinks: Validity and effectiveness"

12/06/2018 **Poster**, *"Chaos, quantum chaos and more" conference*, Centro Internacional de Ciencias (Cuernavaca, Morelos, Mexico)
Title: "Temperature of a single chaotic eigenstate"

27/03/2018 **Talk**, *Facoltà di Scienze Matematiche, Fisiche e Naturali – Università Cattolica del Sacro Cuore*, Brescia (Italy)
Title: "Superabsorption of light: from Dicke to quantum engineering"

12/12/2017 **Talk**, *Facoltà di Scienze Matematiche, Fisiche e Naturali – Università Cattolica del Sacro Cuore*, Brescia (Italy)
Title: "Cooperative effects in light-harvesting systems"

27/09/2017 **Poster**, *"Transport at the Nanoscale: Molecules, Graphene and more" conference*, Centro Internacional de Ciencias (Cuernavaca, Morelos, Mexico)
Title: "Cooperativity and scalability of light-harvesting devices by separating absorption from transmission"

21/09/2017 **Talk**, *"Transport at the Nanoscale: Molecules, Graphene and more" conference*, Centro Internacional de Ciencias (Cuernavaca, Morelos, Mexico)
Title: "Cooperativity and scalability of light-harvesting devices by separating absorption from transmission"

12/09/2017 **Talk**, *Instituto de Física – Benemérita Universitád Autónoma de Puebla*, Puebla (Mexico)
Title: "Cooperativity and scalability of light-harvesting devices by separating absorption from transmission"

29/06/2017 **Poster**, *"XXII National Conference on Statistical Physics and Complex Systems" conference*, Università degli Studi di Parma (Parma, Italy)
Title: "Decoupling absorption from transmission in light-harvesting devices"

Attended Scientific Workshops, Schools and Courses

I have attended 20 international scientific workshops, 3 training schools and 5 PhD-level courses.

28–31/10/2024 **Workshop**, *JMC 2024*, Marseille (France)

17–18/06/2024 **Workshop**, *Challenges and perspectives in resonator-mediated quantum many-body physics: From atoms to solid state*, Zurich (Switzerland)

27–31/05/2024 **Workshop**, *E-MRS*, Strasbourg (France)

21–23/05/2024 **Workshop**, *CAFQA*, Ottawa (Canada)

03–08/03/2024 **Workshop**, *APS March Meeting 2024*, Minneapolis (USA)

04–08/09/2023 **Workshop**, *CMD30 FisMat*, Milan (Italy)

18–28/07/2023 **School**, *Quantum localization and Glassy physics*, Cargèse (France)

18–22/06/2023 **Workshop**, *EGAS 54*, Strasbourg (France)

05–10/03/2023 **School**, *Out-of-equilibrium physics with photons and atoms*, Les Houches (France)

12–16/12/2022 **Workshop**, *2nd Workshop on Molecular Quantum Technology - MQT 2022*, Puerto Natales (Chile)
Organized by Universidad de Santiago de Chile (Santiago, Chile)

24–27/08/2021 **Workshop**, *17èmes journées de la matière condensée*, online
Organized by Société Française de Physique (France)

01–02/07/2021 **Workshop**, *Wave International Networking Event*, online
Organized by Université Côte d'Azur (Nice, France)

23–25/06/2021 **Workshop**, *I Conference of the Italian Society of Statistical Physics - SIFS*, online
Organized by Università degli Studi di Parma (Parma, Italy)

08–12/03/2021 **Workshop**, *nanoGe*, online
Organized by Fundació Scito

02–04/09/2020 **Workshop**, *CMD2020GEFES*, online
Organized by European Physical Society

04–08/11/2019 **Workshop**, *Non-Hermitian Quantum Systems*, Centro Internacional de Ciencias (Cuernavaca, Morelos, Mexico)

27–31/10/2019 **Workshop**, *Quantum Effects in Biological Systems (QuEBS)*, Benemérita Universitád Autónoma de Puebla (Puebla, Mexico)

22–26/10/2018 **Workshop**, *Quantum Biology*, Centro Internacional de Ciencias (Cuernavaca, Morelos, Mexico)

04–22/06/2018 **Workshop**, *Chaos, quantum chaos and more*, Centro Internacional de Ciencias (Cuernavaca, Morelos, Mexico)

13/02/2018 **PhD Course**, *Materials and technologies for high-efficiency solar cells: from standards to nanostructures*, Facoltà di Scienze Matematiche, Fisiche e Naturali - Università Cattolica del Sacro Cuore (Brescia, Italy)
By Prof. Antonio Terrasi (Università degli Studi di Catania, Catania, Italy)

05–08/02/2018 **PhD Course**, *Methods of numerical resolution of ODE systems: theory, implementation and applications*, Facoltà di Scienze Matematiche, Fisiche e Naturali - Università Cattolica del Sacro Cuore (Brescia, Italy)
By Prof. Adolfo Avella (Università degli Studi di Salerno, Salerno, Italy)

11–12/01/2018 **PhD Course**, *Understanding materials by molecular dynamics simulations*, Facoltà di Scienze Matematiche, Fisiche e Naturali - Università Cattolica del Sacro Cuore (Brescia, Italy)
By Dr. Claudia Caddeo (IOM-CNR, Cagliari, Italy)

18/09–07/10/2017 **Workshop**, *Transport at the Nanoscale: Molecules, Graphene and more*, Centro Internacional de Ciencias (Cuernavaca, Morelos, Mexico)

07/08–30/10/2017 **PhD Course**, *Introduction to Classical and Quantum Chaos*, Instituto de Física, Benemérita Universitád Autónoma de Puebla (Puebla, Mexico)
By Prof. Felix M. Izrailev

28–30/06/2017 **Workshop**, *XXII National Conference on Statistical Physics and Complex Systems*, Università degli Studi di Parma (Parma, Italy)

08–22/06/2017 **PhD Course**, *Wave processes in random media: physical principles, mathematical methods, and applications*, Facoltà di Scienze Matematiche, Fisiche e Naturali - Università Cattolica del Sacro Cuore (Brescia, Italy)
By Prof. Valentin Freilikher (Bar-Ilan University Ramat-Gan, Israel)

27/06–01/07/2016 **Workshop**, *IWDS10 - International Workshop on Disordered Systems*, Facoltà di Scienze Matematiche, Fisiche e Naturali - Università Cattolica del Sacro Cuore (Brescia, Italy)

20–24/06/2016 **School**, *2nd School on Scientific Data Analytics and Visualization*, CINECA (Bologna, Italy)