

# Domenico Monaco

Partecipazione alla procedura selettiva di chiamata per n. 1 posto di Ricercatore a tempo determinato – Tipologia B presso il Dipartimento di Matematica, Facoltà di Scienze Matematiche, Fisiche e Naturali dell'Università degli Studi di Roma "La Sapienza", Settore Scientifico-disciplinare MAT/07, Settore concorsuale 01/A4, di cui al bando emanato con D.R. n. 2267/2021 con avviso pubblicato sulla G.U. — IV serie speciale n. 69 in data 31/07/2021, codice concorso 2021RTDB022.

## AI FINI DELLA PUBBLICAZIONE

### Academic Positions

- 10/2019 – **Research fellow (Ricercatore a Tempo Determinato, tipo "A") in Mathematical Physics**  
Department of Mathematics "G. Castelnuovo", SAPIENZA Università di Roma, Rome (Italy)
- 10/2017 – 10/2019 **Postdoctoral researcher in Mathematical Physics**  
Department of Mathematics and Physics, Università degli Studi Roma Tre, Rome (Italy)  
*Advisor:* prof. Alessandro Giuliani  
Funded by the ERC Consolidator Grant 2016 UniCoSM - Universality in Condensed Matter and Statistical Mechanics
- 10/2015 – 09/2017 **Postdoctoral researcher in Mathematical Physics**  
Department of Mathematics, Eberhard Karls Universität, Tübingen (Germany)  
*Advisor:* prof. Stefan Teufel  
Funded by the Graduiertenkolleg 1838 "Spectral Theory and Dynamics of Quantum Systems"

### Education, Degrees and Qualifications

- 09/2019 – 09/2025 **Abilitazione Scientifica Nazionale al ruolo di Professore di II Fascia**  
Settore Concorsuale 01/A4 – Fisica Matematica, Italy
- 02/2018 – 12/2022 **Qualification aux fonctions de maître de conférences**  
Section 25 "Mathématiques" (qual. no. 18225319357D) and Section 26 "Mathématiques appliquées et applications des mathématiques" (qual. no. 18226319357D), France
- 10/2011 – 09/2015 **Ph.D. in Mathematical Physics, Area of Mathematics**  
SISSA, Trieste (Italy), awarded *cum laude*  
*Title of the thesis:* Geometric phases in graphene and topological insulators  
*Advisor:* prof. Gianluca Panati (SAPIENZA Università di Roma)  
*Date of dissertation:* September 15th, 2015  
Position with scholarship
- 10/2009 – 07/2011 **Master degree (Laurea specialistica) in Mathematics**  
SAPIENZA, Università di Roma (Italy), awarded 110/110 *cum laude*  
*Title of the thesis:* A geometric approach to the decay of Wannier functions in graphene  
*Advisor:* prof. Gianluca Panati, prof. Domenico Fiorenza (coadvisor)  
*Date of dissertation:* July 21st, 2011
- 10/2006 – 07/2009 **Bachelor degree (Laurea triennale) in Mathematics**  
SAPIENZA, Università di Roma (Italy), awarded 110/110 *cum laude*  
*Title of the thesis:* Euler equation (a geometric description)  
*Advisor:* prof. Domenico Fiorenza  
*Date of dissertation:* July 14th, 2009

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## Teaching Experience

### Lecturer

- Fall 2021 **Metodi Matematici in Meccanica Quantistica (Mathematical Methods in Quantum Mechanics)**  
SAPIENZA Università di Roma, Rome (Italy)  
*Course taught by:* prof. Alessandro Teta  
*Class:* second year, Master course in Mathematics
- Fall 2020 **Fisica Matematica Superiore (Higher Mathematical Physics)**  
SAPIENZA Università di Roma, Rome (Italy)  
*Course taught by:* prof. Alessandro Teta  
*Class:* second year, Master course in Mathematics  
Four lectures on magnetic Schrödinger operators
- Fall 2019-20-21 **Matematica (Mathematics)**  
SAPIENZA Università di Roma, Rome (Italy)  
*Class:* first year, Bachelor degree (Laurea Triennale) in Biotechnologies
- Spring 2019 **Topological quantum matter**  
Università degli Studi di Roma Tre, Rome (Italy)  
*Class:* first year, Ph.D. course in Mathematics
- Spring 2018 **K-theory in condensed matter physics**  
Università degli Studi di Roma Tre, Rome (Italy)  
*Class:* first year, Ph.D. course in Mathematics
- Spring 2016 **K-theory in condensed matter physics**  
Eberhard Karls Universität, Tübingen (Germany)  
*Class:* Ph.D. course in Mathematical Physics
- Spring 2014 **Introduction to Topological Insulators**  
SISSA, Trieste (Italy)  
*Course taught by:* prof. Giuseppe Santoro  
*Class:* first year, Ph.D. course in Condensed Matter Physics  
Two concluding lectures on geometric aspects of periodic Schrödinger operators
- Spring 2014 **Basics of Noncommutative Geometry**  
SISSA, Trieste (Italy)  
*Course taught by:* dr. Jens Kaad  
*Class:* first year, Ph.D. course in Mathematical Physics  
Two lectures on noncommutative topology and GNS representations

### Teaching Assistant

- Fall 2012-13-14 **Istituzioni di Fisica Matematica (Foundations of Mathematical Physics) – mod. A, exercise sessions**  
SISSA and Università degli Studi di Trieste, Trieste (Italy)  
*Course taught by:* prof. Ludwik Dabrowski (2012), prof. Alessandro Tanzini (2013–2014)  
*Class:* first year, Master degree (Laurea magistrale) in Mathematics

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## Publications and Preprints

### Peer-reviewed publications

- [16] Beyond Diophantine Wannier diagrams: Gap labelling for Bloch–Landau Hamiltonians [joint with H. Cornean and M. Moscolari]. *J. Eur. Math. Soc.* **23**, Issue 11, 3679–3705 (2021).
- [15] Středa formula for charge and spin currents [joint with M. Moscolari]. *Rev. Math. Phys.* **33**, Issue 1, 2060003 (2021).
- [14] Spin Hall conductivity in insulators with non-conserved spin [joint with L. Ulčakar]. *Phys. Rev. B* **102**, Issue 12, 125138 (2020).
- [13] Parseval frames of exponentially localized magnetic Wannier functions [joint with H. Cornean and M. Moscolari]. *Commun. Math. Phys.* **371**, Issue 3, 1179–1230 (2019).
- [12] Localised Wannier functions in metallic systems [joint with H. Cornean, D. Gontier, and A. Levitt]. *Ann. Henri Poincaré* **20**, Issue 4, 1367–1391 (2019).
- [11] Adiabatic currents for interacting electrons on a lattice [joint with S. Teufel]. *Rev. Math. Phys.* **31**, Issue 3, 1950009 (2019).
- [10] The Haldane model and its localization dichotomy [joint with G. Marcelli, M. Moscolari, and G. Panati]. *Rend. Mat. Appl.* **39**, Issue 2, 307–327 (2018).
- [9] Optimal decay of Wannier functions in Chern and Quantum Hall insulators [joint with G. Panati, A. Pisante, and S. Teufel]. *Commun. Math. Phys.* **359**, Issue 1, 61–100 (2018).
- [8] On the construction of Wannier functions in topological insulators: the 3D case [joint with H. Cornean]. *Ann. Henri Poincaré* **18**, Issue 12, 3863–3902 (2017).
- [7] Gauge-theoretic invariants for topological insulators: A bridge between Berry, Wess–Zumino, and Fu–Kane–Mele [joint with C. Tauber]. *Lett. Math. Phys.* **107**, Issue 7, 1315–1343 (2017).
- [6] Wannier functions and  $\mathbb{Z}_2$  invariants in time-reversal symmetric topological insulators [joint with H. Cornean and S. Teufel]. *Rev. Math. Phys.* **29**, Issue 2, 1730001 (2017).  
**Featured article among “Best of 2017” in *Rev. Math. Phys.***
- [5]  $\mathbb{Z}_2$  invariants of topological insulators as geometric obstructions [joint with D. Fiorenza and G. Panati]. *Commun. Math. Phys.* **343**, Issue 3, 1115–1157 (2016).
- [4] Stability of closed gaps for the alternating Kronig–Penney Hamiltonian [joint with A. Michelangeli]. *Anal. Math. Phys.* **6**, Issue 1, 67–83 (2016).
- [3] Construction of real-valued localized composite Wannier functions for insulators [joint with D. Fiorenza and G. Panati]. *Ann. Henri Poincaré* **17**, Issue 1, 63–97 (2016).
- [2] Symmetry and localization in periodic crystals: triviality of Bloch bundles with a fermionic time-reversal symmetry [joint with G. Panati]. *Acta Appl. Math.* **137**, Issue 1, 185–203 (2015).
- [1] Topological invariants of eigenvalue intersections and decrease of Wannier functions in graphene [joint with G. Panati]. *J. Stat. Phys.* **155**, Issue 6, 1027–1071 (2014).

### Peer-reviewed conference proceedings

- [1] Chern and Fu–Kane–Mele invariants as topological obstructions. Proceedings of the INdAM meeting “Contemporary Trends in the Mathematics of Quantum Mechanics”, Rome (Italy). Chapter 12 in: G. Dell’Antonio and A. Michelangeli (eds.), *Advances in Quantum Mechanics: Contemporary Trends and Open Problems*, vol. 18 in Springer INdAM Series (2017).

### Other

- [1]  $KK$ -theory, gauge theory and topological phases [joint with F. Arici]. *Nieuw Archief voor Wiskunde* **5/18**, Issue 4, 257–262 (2017).

### Preprints

- [1] The Localization Dichotomy for gapped periodic quantum systems [joint with G. Panati, A. Pisante, and S. Teufel]. Preprint available at arXiv:1612.09557.

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## Scientific Communications

### Invited talks

- 25–27/08/2021 **SOLID MATH 2021**  
École des Ponts, Marne la Vallée (France)  
*Title of the contribution:* Topology vs localization in synthetic dimensions
- 2–7/08/2021 **XX International Congress of Mathematical Physics**  
International Conference Centre (CICG), Geneva (Switzerland)  
*Title of the contribution:* (De)localized Wannier functions for quantum Hall systems  
Contributed talk
- 17–28/05/2021 **SIAM MS21 – Mathematical Aspects of Materials Science**  
Basque Center for Applied Mathematics, Bilbao (Spain)  
*Title of the contribution:* (De)localized Wannier functions for quantum Hall systems  
Contributed talk in the Mini-Symposium “Waves in Topological Materials”
- 22–25/02/2021 **Mathematics of Condensed Matter and Beyond**  
Center for Advanced Mathematical Sciences, American University of Beirut (Lebanon)  
*Title of the contribution:* (De)localized Wannier functions for quantum Hall systems  
Contributed talk
- 3–4/02/2020 **Noncommutative Geometry, Analysis, and Topological Insulators**  
Mathematisch Instituut, Leiden University (Netherlands)  
*Title of the contribution:* Parseval frames of exponentially localized magnetic Wannier functions
- 2–7/09/2019 **XXI Congresso dell’Unione Matematica Italiana**  
Sede centrale, Università degli Studi di Pavia (Italy)  
*Title of the contribution:* Localization dichotomy for periodic insulators  
Contributed talk
- 12–16/08/2019 **QMath 14: Mathematical Results in Quantum Physics**  
Department of Mathematics, Aarhus Universitet (Denmark)  
*Title of the contribution:* (De)localized Wannier functions for Chern and quantum Hall insulators
- 3–6/09/2018 **Recent progress in mathematics of topological insulators**  
ETH, Zürich (Switzerland)  
*Title of the contribution:* A bird’s-eye view on  $\mathbb{Z}_2$  topology
- 1–3/08/2018 **SOLID MATH 2018**  
McGill University, Montréal (Canada)  
*Title of the contribution:* Adiabatic currents for interacting electrons on a lattice
- 23–28/07/2018 **XIX International Congress of Mathematical Physics**  
Centre Mont Royal, Montréal (Canada)  
*Title of the contribution:* Derivation of a Kubo-like formula for charge and spin transport  
Contributed talk
- 28–30/05/2018 **Analytical & Numerical Methods in Quantum Transport**  
Department of Mathematics, Universitet Aalborg (Denmark)  
*Title of the contribution:* Kubo formula for the quantum (spin) Hall conductivity: a microscopic derivation
- 19–24/02/2018 **Mathematical Challenges in Quantum Mechanics 2018**  
SAPIENZA, Università di Roma (Italy)  
*Title of the contribution:* Derivation of a Kubo-like formula for charge and spin transport  
Contributed talk
- 20–24/02/2017 **Trieste Quantum Days 2017**  
SISSA, Trieste (Italy)  
*Title of the contribution:* Localization dichotomy for gapped periodic quantum systems
- 4–8/07/2016 **Contemporary Trends in the Mathematics of Quantum Mechanics**  
INdAM headquarters, Rome (Italy)  
*Title of the contribution:* Chern and Fu–Kane–Mele invariants as topological obstructions

- 26–28/05/2016 **Solid Math 2016**  
Department of Mathematics, Universitet Aalborg (Denmark)  
*Title of the contribution:* Obstruction theory for time-reversal symmetric topological insulators and  $\mathbb{Z}_2$  invariants
- 8–10/06/2015 **Trails in Quantum Mechanics and Surroundings 2015**  
Dipartimento di Scienza e Alta Tecnologia, Università degli Studi dell'Insubria, Como (Italy)  
*Title of the contribution:* Stability of closed gaps for the alternating Kronig–Penney Hamiltonian
- 1–5/06/2015 **Mathematics of Novel Materials**  
Mittag-Leffler Institute, Djursholm (Sweden)  
*Title of the contribution:*  $\mathbb{Z}_2$  invariants of time-reversal symmetric topological insulators as geometric obstructions
- 20/12/2013 **Trails in Quantum Mechanics and Surroundings 2014**  
SAPIENZA, Università di Roma (Italy)  
*Title of the contribution:* Topological invariants of eigenvalue intersections and decrease of Wannier functions in graphene
- 1–5/07/2013 **Geometrical Aspects of Quantum States in Condensed Matter**  
ICTP, Trieste (Italy)  
*Title of the contribution:* Topological invariants of eigenvalue intersections and decrease of Wannier functions in graphene  
Contributed talk
- 29–31/05/2013 **Conical Intersections in Mathematical Physics**  
Institute Henri Poincaré, Paris (France)  
*Title of the contribution:* Topological invariants of eigenvalue intersections and decrease of Wannier functions in graphene

## Colloquia

- 11/05/2017 **Colloquium of the Center for Mathematical Physics**  
GEOMATIKUM, Hamburg (Germany)  
*Title of the contribution:* Topological and gauge-theoretic invariants in condensed matter systems

## Seminars

- 17/11/2017 **CEREMADE Seminar**  
Université Paris–Dauphine, Paris (France)  
*Title of the contribution:* Adiabatic currents for interacting electrons on a lattice
- 27/06/2017 **Gæsteforelæsning**  
Aalborg Universitet, Aalborg (Denmark)  
*Title of the contribution:* Construction of localized Wannier functions for topological insulators
- 2/05/2017 **Mathematical Physics seminars**  
Università di Roma Tre, Roma (Italy)  
*Title of the contribution:* (De)localization in topological insulators: a Wannier-function approach
- 22/06/2016 **Trieste Quantum Days – solid, stat, et al**  
SISSA, Trieste (Italy)  
*Title of the contribution:* Topological obstructions in solid state physics
- 22/04/2016 **Mathematical Physics seminars**  
Friedrich-Alexander Universität, Erlangen-Nürnberg (Germany)  
*Title of the contribution:* Obstruction theory for time-reversal symmetric topological insulators and  $\mathbb{Z}_2$  invariants
- 4/12/2015 **Stuttgart–Tübingen Doktorandenseminar**  
Eberhard Karls Universität, Tübingen (Germany)  
*Title of the contribution:* Topology vs Localization in Periodic Media
- 13/05/2015 **Deformation, twisting, and all that**  
Dipartimento di Matematica e Geoscienze, Università degli Studi di Trieste (Italy)  
*Title of the contribution:* Topological phases of quantum matter: Chern numbers in the lab
- 17/12/2014 **Mathematical Physics seminars**  
Eberhard Karls Universität, Tübingen (Germany)  
*Title of the contribution:* Geometry in Solid State Physics: the case study of topological insulators
- 3/12/2014 **Mathematical Physics seminars**  
SAPIENZA, Università di Roma (Italy)  
*Title of the contribution:* Geometry in Solid State Physics: the case study of topological insulators
- 7 and 14/07/2014 **Quantum seminars**  
ICTP, Trieste (Italy)  
*Title of the contribution:* (1) Topological quantum phases in Solid State Physics  
(2) Topological invariants of eigenvalue intersections and decrease of Wannier functions in graphene

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## Organization of Events

### Workshops

- 23–25/09/2019 **Quantum Transport and Universality: From Topological Materials to Quantum Hydrodynamics**  
Accademia Nazionale dei Lincei, Rome (Italy)
- 16–18/06/2014 **SOLID MATH**  
SISSA, Trieste (Italy)
- 8–12/04/2013 **Quantum Geometry and Matter**  
SISSA, Trieste (Italy)

### Schools

- 16–20/09/2019 **Quantum Transport and Universality: From Topological Materials to Quantum Hydrodynamics**  
Università degli Studi di Roma Tre, Rome (Italy)
- 11–15/06/2018 **Universality in Probability Theory and Statistical Mechanics (EMS-IAMP Summer School in Mathematical Physics)**  
Grand Hotel delle Terme Re Ferdinando, Ischia (Italy)
- 24–26/07/2017 **Young Researchers School on Image Processing and Computer Vision**  
Eberhard Karls Universität Tübingen, Tübingen (Germany)

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## Service to the Scientific Community

- Reviewer *Annales Henri Poincaré*, *Documenta Mathematica*, *Journal of Mathematical Physics*, *Letters in Mathematical Physics*, *Nuclear Physics B*, *Physics Letters A*, *Reviews in Mathematical Physics*, *Transactions of the American Mathematical Society*

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## Grants

- 02/2021–07/2022 **Principal Investigator:** “Correnti di spin in presenza di interazioni spin-orbita e campi magnetici”  
Progetto Giovani GNFM 2020  
*Funded by:* INdAM–GNFM  
*Grant awarded:* €1.750  
2 participants
- 12/2020–12/2023 **Principal Investigator:** “Aspetti matematici delle interazioni fra particelle quantistiche: modelli efficaci, trasporto e topologia”  
Progetto di Ricerca Medio  
*Funded by:* SAPIENZA Università di Roma  
*Grant awarded:* €12.000  
4 participants
- 07/2014–07/2015 **Participant:** “Metodi matematici per lo studio degli isolanti topologici”  
Progetto Giovani GNFM 2014  
*Funded by:* INdAM–GNFM  
*Grant awarded:* €1.600  
2 participants, P.I.: prof. Gianluca Panati (SAPIENZA Università di Roma)

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## Professional Affiliations

- 2020 – Società Italiana di Matematica Applicata e Industriale (SIMAI)
- 2019 – International Association of Mathematical Physics (IAMP)
- 2019 – Unione Matematica Italiana (UMI)
- 2012 – Gruppo Nazionale per la Fisica Matematica, Istituto Nazionale di Alta Matematica (GNFM–INdAM)
- 10/2015 – 09/2017 Graduiertenkolleg (GRK) 1838 “Spectral Theory and Dynamics of Quantum Systems”

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## Administrative Experience

- 11/2014 – 09/2015 Students' representative in SISSA Evaluation Unit  
04/2014 – 09/2015 Students' representative in SISSA School Council for the Area of Mathematics  
04/2012 – 03/2014 Students' representative for the Ph.D. course in Mathematical Physics, SISSA Area of Mathematics

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## Languages

Italian **Mothertongue**  
English **Proficient**  
German **Elementary**

*Cambridge Certificate of Advanced English (2006); CEFR C1/C2*

*CEFR A2/B1*