Dr Giacomo Prando

Curriculum Vitae et Studiorum (last update: 27th August, 2024)

1. Personal information

Year and place of birth	
Nationality	
Telephone number (office)	
Researcher unique identifiers	0000-0002-7722-6599 (ORCID) ISU-9686-2023 (ResearcherID) 6602307937 (Scopus)
E-mail	
Webpage	nmrphysics.unipv.it/people/prando/

2. Studies and education

March 2012	Defence of the **Ph. D. thesis** "Phase Diagrams of $REFeAsO_{1-x}F_x$ Materials: Macroscopic and Nanoscopic Experimental Investigation", supervisor Prof. Pietro Carretta.
November 2008 – December 2011	**Ph. D.** in "Physical Sciences of Matter" with a grant awarded by the National Interuniversity Consortium for the Physical Sciences of Matter (C.N.I.S.M.) at **Università degli Studi Roma Tre**, Italy.
September 2006 – September 2008	**Master of Science** in "Physical Sciences" (specialization in Condensed Matter Physics) at **Università degli Studi di Pavia**, Italy. Thesis "Dilution effects in $Ho_{2-x}Y_xSn_2O_7$. From the Spin Ice to the single-ion magnet", full marks with distinction (110/110 e lode), supervisor Prof. Pietro Carretta.
September 2003 – December 2006	**Bachelor** in "Physics" at **Università degli Studi di Pavia**, Italy. Thesis "*Fluttuazioni superconduttive e diamagnetiche nella regione critica di nanoparticelle metalliche*", full marks with distinction (110/110 e lode), supervisor Prof. Attilio Rigamonti.
September 2003 – May 2009	Class of Science e Technologies (VIII cycle) at the **I.U.S.S. – School for Advanced Studies**, Pavia, Italy. Graduation thesis "Power-law distributions in nature and society", supervisor Prof. Guido Montagna.
September 2003 – July 2008	Fellow of **Collegio Ghislieri**, Pavia, Italy, ranked by the Italian Ministry of Education, University and Research as Highly Qualifying Institution under the High Patronage of the Presidency of the Italian Republic, with first-year admission by national competitive examination.

Language skills

Italian	Mother tongue.
English	Spoken: *fluent*. Written: *fluent*. Oral comprehension: *fluent*.
Spanish	Spoken: *good*. Written: *good*. Oral comprehension: *good*.
German	Spoken: *fair*. Written: *good*. Oral comprehension: *fair*.

3. Working positions

Current position

October 2021 – to date	**Assistant professor** (*ricercatore RtdB*) at the **Department of Physics of Università degli Studi di Pavia**, Italy.

Past positions

November 2017 – September 2021	**Research associate** (*ricercatore RtdA*) at the **Department of Physics of Università degli Studi di Pavia**, Italy.
March 2016 – November 2017	**Associate editor** at **Nature Nanotechnology**, Springer Nature, London, UK.
July 2015 – February 2016	**Post-doctoral researcher** at **Technische Universität Dresden**, Germany.
January 2012 – June 2015	**Post-doctoral researcher** at **Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden**, Germany.

4. Honors and awards

December 2023	Successfully evaluated within the **Italian National Scientific Qualification** (*Abilitazione Scientifica Nazionale*). Qualified to become **Full Professor** (Experimental Condensed Matter Physics, 02/B1) in Italy until 6th December 2034.
March 2018	Successfully evaluated within the **Italian National Scientific Qualification** (*Abilitazione Scientifica Nazionale*). Qualified to become **Associate Professor** (Experimental Condensed Matter Physics, 02/B1) in Italy until 30th March 2029.
September 2011	**"A. Righi" Prize for Scientific Industry of Young Scientists** (Italian Physical Society).

5. Research activity

Grants and projects

December 2022 - November 2025	**Member** of Spoke 7, "Complete quantum systems," of the **National Quantum Science and Technology Institute** (Enlarged Partnerships extended to Universities, Research Centres, Enterprises under the National Recovery and Resilience Plan, funded by the European Union – NextGenerationEU) at Università degli Studi di Pavia.
November 2017 - February 2020	**Member** of the **Progetto di Rilevante Interesse Nazionale (PRIN)** "Controlling multi-band quantum materials by orbital manipulation" (2015 call, funded by the Italian Ministry of Education, University and Research) at Università degli Studi di Pavia.
July 2015 - February 2016	**Member** of the **Sonderforschungsbereichs (SFB)** 1143 "Correlated magnetism: from frustration to topology" (funded by the Deutsche Forschungsgemeinschaft – DFG) at Technische Universität Dresden.
July 2013 – June 2015	**Post-doctoral research fellow** of the **Alexander von Humboldt Stiftung** with the individual Research Fellowship for Postdoctoral Researchers "Local features of magnetism in 3D topological insulators investigated by unconventionally-detected electron spin resonance" at Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden.
July 2012 – June 2013	**Post-doctoral research fellow** of the **Deutscher Akademischer Austausch Dienst** with the individual Leibniz-DAAD Research Fellowship "Local features of magnetism in 1111 oxy-pnictide materials" at Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden.

Research interests

My research activity concerns solid state physics and, in particular, **magnetism and superconductivity in condensed matter** from an experimental perspective. Starting from the measurements I performed in 2006 within the framework of my Bachelor thesis, and up to my current work as assistant professor, I have been researching on **superconductors**, both conventional (lead nanoparticles) and unconventional with high critical transition temperatures (iron-based oxy-pnictides). I have focused on the microscopic study of electronic phase diagrams and of the ***coexistence of magnetism and superconductivity*** as a function of different tuning parameters, both chemical (substitutions) and physical (pressure). I have studied physical phenomena characteristic of the superconducting phase as well, such as the ***vortex motion*** and the ***amplitude and/or phase fluctuations of the superconducting order parameter*** at temperatures higher than the critical T_c. I have worked on electronic phase diagrams and magnetic properties of several **strongly-correlated electron systems** such as cuprates and, more recently, of **topological phases of matter** resulting from the coexistence of electronic correlations and spin-orbit interaction (iridium-based oxides). Finally, I have investigated the exotic magnetism arising in **geometrically-frustrated magnets** on tri-dimensional lattices (spin-ice, molybdenum-based pyrochlores) and in metal-organic frameworks.

Technical skills

I am well-experienced in several techniques of magnetic investigation, of both macroscopic and local nature. **Dc magnetometry** and **magnetic ac susceptometry** belong to the former class. The latter class is composed by most of the magnetic spectroscopies such as **muon-spin rotation** (μ^+SR), **nuclear magnetic resonance** (NMR), and **electron spin resonance** (ESR). For both μ^+SR and dc magnetometry, I have gained a substantial experience with experimental set-ups enabling the application of **external pressures** (up to 6 GPa). As complementary techniques, I also have experience in measurements of **electrical transport** (resistivity) and **calorimetry** (specific heat).

Noteworthy results of my research activity

• I tackled the mobility of flux lines in the mixed phase of iron-based superconductors – a topic rich with important implications for both fundamental and application-oriented research. To this aim, I performed measurements of ac susceptibility on both powder and single-crystal samples. My first results were relative to compounds belonging to the 1111 family and were published in *Physical Review B* **83** 174514and *Physical Review B* **85** 144522. Here, I investigated the magnetic field – temperature phase diagram delimiting the regions where flux lines are not static, resulting in energy dissipation. Also, I quantified the characteristic energies for the pinning processes involving structural defects. More recently, I expanded these results to other families of iron-based superconductors (*Journal of Physics: Condensed Matter* **25** 505701), where the phenomenology is different and reveals a critical scaling characteristic of a phase transition between solid and liquid phases for the flux lines.

• One of the first interesting experimental observations about iron-based superconductors belonging to the 1111 family has been the strong dependence of the maximum value of the critical temperature T_c on the lanthanoid element in the material. I focused on the comprehension of this phenomenology considering undoped, non-superconducting 1111 compounds based on Co. These materials are characterized by a ferromagnetic ground state which I investigated by means of muon spin spectroscopy under external pressure. Based on the results published in *Physical Review B* **87** 064401and *Physical Review B* **92** 144414I showed that the effect of pressure is quantitatively equivalent to that of the structural distortions induced by progressively increasing the size of the lanthanoid elements. These results were propaedeutical to the comprehension of superconducting systems under the effect of chemical and external pressures, allowing me to evidence the crucial effect of quenched disorder and non-magnetic defects – as I showed in *Physical Review Letters* **114** 247004.

• Among molecular machines, rotating functional chemical groups with highly controlled properties are of particular importance. In this context, recent research activities have been devoted to the synthesis of porous metal-organic frameworks where the rotating moieties are sustained along well-defined orientations by a fixed crystalline structure acting as stator. Using nuclear magnetic resonance, I was able to characterize the rotary dynamics of organic moieties embedded in a Zn-based metal-organic framework where ultrafast rotations are exceptionally preserved down to a few Kelvins, as published in *Nature Chemistry* **12** 845. Also, I demonstrated for the first time the feasibility of an analogous experimental investigation using muon-spin spectroscopy, publishing the results in *Nano Letters* **20** 7613.

Bibliometrics

Publications in peer-reviewed journals	**45** Among these: 1 on *Nature Chemistry*, 1 on *Nature Communications*, 1 on *Nano Letters*, 4 on *Physical Review Letters* and 23 on *Physical Review B*. I am first author in 20 papers.
Books	**1** (Ph. D. Thesis)
Other publications	**30** Among these: 27 single-author contributions on *Nature Nanotechnology* and *Nature Physics*.

Citations	**793** **817**	(Web of Science) (Scopus)	***h* index**	**18** **18**	(Web of Science) (Scopus)

Peer review

Research assessment	ANVUR (Italian National Agency for the Evaluation of Universities and Research Institutes), Croatian Science Foundation, National Science Centre Poland.
Scientific journals	Physical Review Letters, Physical Review X, Physical Review B, Physical Review Materials, New Journal of Physics, Journal of Physics: Condensed Matter, Superconductor Science and Technology, Physica Status Solidi B, NPG Asia Materials.
Publishing houses	Oxford University Press.

6. Conferences, workshops and seminal activity

Invited talks at conferences and workshops	**7** (see the list below, numbered It#.)	**Invited talks and seminars in Universities**	**8**	**Contributed talks at conferences and workshops**	**23**

It7. June 2024	International conference “Superstripes 2024” – Ischia, Italy. Talk “Preformed magnetic clusters in the paramagnetic phase of a high-temperature ferromagnetic MOF”.
It6. June 2023	International conference “Superstripes 2023” – Ischia, Italy. Talk “Coexisting superconductivity and charge-density wave in hydrogen-intercalated $TiSe_2$”.
It5. April 2018	International conference “6th International Conference on Superconductivity and Magnetism – ICSM2018” – Antalya, Turkey. Talk “Fe- and Co-based oxypnictides: Structural tuning of electronic ground states”.
It4. March 2015	Workshop “3rd ERC Symposium QuantumPuzzle” – Vienna University of Technology, Wien, Austria. Talk “μ^+SR under pressure: investigations of magnetism and superconductivity in iron-based pnictides”.
It3. June 2014	Workshop “Itinerant Magnetism and Superconductivity - IMS 2014” – Dresden, Germany. Talk “Chemical dilutions, external and chemical pressures. Electronic phase diagrams of 1111 oxy-pnictides investigated by means of μ^+SR”.
It2. October 2013	Workshop “Hot Topics in HTSC: Fe-Based Superconductors” – Zvenigorod, Moscow, Russia. Talk “Electronic phase diagrams of 1111 oxy-pnictides investigated by means of muon spin spectroscopy”.
It1. October 2011	Workshop “Highlights in Condensed Matter Physics - Superconductivity and Magnetism” – Università degli Studi di Pavia, Pavia, Italy. Talk “NMR, μ^+SR and AC susceptibility in Fe-based superconductors”.

Organization

February 2024	National Conference"Magnet2024 – VIII Italian conference on magnetism" – Milano, Italy.
August 2022	International Conference"Muon Spin Rotation, Relaxation and Resonance μSR2020" – Parma, Italy.
October 2017	Nature Conference "Ferroic Materials: Challenges and opportunities" – Xi'an, China.
July 2014	Workshop "NμM2014: NMR, μ^+SR, Mössbauer spectroscopies in the study of Fe-based and other unconventional high-T_c superconductors", Leibniz-Institut für Festkörper- und Werkstoffforschung – Dresden, Germany.

Editorial activity

August 2022	Editor of theconference proceedingsof theInternational Conference"Muon Spin Rotation, Relaxation and Resonance μSR2020" – Parma, Italy.

7. Teaching, supervision and educational activities

Teaching

March 2024 – June 2024	**Lecturer** for the course "Struttura della materia" ("Structure of matter"), problem solving (20 hours), three-year Bachelor in Physics, Università degli Studi di Pavia.
March 2024 – April 2024	**Lecturer** for the course "Termodinamica" ("Thermodynamics" – 30 hours), Degree program in Building Engineering and Architecture, Università degli Studi di Pavia.
October 2023 – December 2023	**Lecturer** for the course "Magnetismo e superconduttività" ("Magnetism and superconductivity", 48 hours), two-year Master in Physical Sciences, Università degli Studi di Pavia.
June 2023	**Lecturer** for the course "Introduzione alla fisica dei solidi" ("Introduction to solid state physics"), lecture on superconductivity (2 hours), three-year Bachelor in Physics, Università degli Studi di Pavia.
March 2023	**Lecturer** for the course "Soft Skills", module on Scientific Writing (6 hours), Ph. D. in Physics, Università degli Studi di Pavia.
March 2023 – June 2023	**Lecturer** for the course "Struttura della materia" ("Structure of matter"), problem solving (20 hours), three-year Bachelor in Physics, Università degli Studi di Pavia.
October 2022 – December 2022	**Lecturer** for the course "Magnetismo e superconduttività" ("Magnetism and superconductivity", 48 hours), two-year Master in Physical Sciences, Università degli Studi di Pavia.
June 2022	**Lecturer** for the course "Introduzione alla fisica dei solidi" ("Introduction to solid state physics"), lecture on superconductivity (2 hours), three-year Bachelor in Physics, Università degli Studi di Pavia.
May 2022	**Lecturer** for the course "Soft Skills", module on Scientific Writing (4 hours), Ph. D. in Physics, Università degli Studi di Pavia.
May 2022	**Lecturer** for the course "Condensed Matter Physics II", lecture on experimental methods in magnetism (2 hours), two-year Master in Physics, Università degli Studi di Roma "La Sapienza."
March 2022 – June 2022	**Lecturer** for the course "Struttura della materia" ("Structure of matter"), problem solving (20 hours), three-year Bachelor in Physics, Università degli Studi di Pavia.
October 2021 – January 2022	**Lecturer** for the course "Magnetismo e superconduttività" ("Magnetism and superconductivity", 48 hours), two-year Master in Physical Sciences, Università degli Studi di Pavia.

June 2021	**Lecturer** for the course “Introduzione alla fisica dei solidi” (“Introduction to solid state physics”), lecture on superconductivity (2 hours), three-year Bachelor in Physics, Università degli Studi di Pavia.
March 2021 – June 2021	**Lecturer** for the course “Struttura della materia” (“Structure of matter”), problem solving (20 hours), three-year Bachelor in Physics, Università degli Studi di Pavia.
October 2020 – December 2020	**Lecturer** for the course “Magnetismo e superconduttività” (“Magnetism and superconductivity”) – module on phase transitions (16 hours) and module on superconductivity (16 hours), two-year Master in Physical Sciences, Università degli Studi di Pavia.
June 2020	**Lecturer** for the course “Introduzione alla fisica dei solidi” (“Introduction to solid state physics”), lecture on superconductivity (2 hours), three-year Bachelor in Physics, Università degli Studi di Pavia.
March 2020 – June 2020	**Lecturer** for the course “Struttura della materia” (“Structure of matter”), problem solving (20 hours), three-year Bachelor in Physics, Università degli Studi di Pavia.
October 2019 – January 2020	**Lecturer** for the course “Magnetismo e superconduttività” (“Magnetism and superconductivity”) – module on phase transitions (16 hours) and module on superconductivity (16 hours), two-year Master in Physical Sciences, Università degli Studi di Pavia.
May 2019	**Lecturer** for the course “Introduzione alla fisica dei solidi” (“Introduction to solid state physics”), lecture on superconductivity (2 hours), three-year Bachelor in Physics, Università degli Studi di Pavia.
April 2019	**Lecturer** for the course “Magnetic Resonance Techniques in Solid State Physics”, module on Electron Spin Resonance (6 hours), Ph. D. in Physics, Università degli Studi di Pavia.
March 2019 – June 2019	**Lecturer** for the course “Struttura della materia” (“Structure of matter”), problem solving (20 hours), three-year Bachelor in Physics, Università degli Studi di Pavia.
December 2018 – January 2019	**Lecturer** for the course “Complementi di struttura della materia” (“Structure of matter – complements”) – module on Superconductivity (16 hours), two-year Master in Physical Sciences, Università degli Studi di Pavia.
March 2018 – May2018	**Lecturer** for the course “Struttura della materia” (“Structure of matter”), problem solving (20 hours), three-year Bachelor in Physics, Università degli Studi di Pavia.
December 2017 – January 2018	**Lecturer** for the course “Complementi di struttura della materia” (“Structure of matter – complements”) – module on Superconductivity (16 hours), two-year Master in Physical Sciences, Università degli Studi di Pavia.
May 2015	**Lecturer** for the course “Magnetic Spectroscopies”, module on Electron Spin Resonance (6 hours), Ph. D. in Physics, Università degli Studi di Pavia.
January 2010	**Seminar** “Monopoli magnetici in ghacci di spin” (“Magnetic monopoles in spin-ice”) for students of the three-year Bachelor in Physics, Università degli Studi di Pavia.

Supervision of students

Master in Physical Sciences – Università degli Studi di Pavia

3. C. Aloisi (currently under supervision).
2. S. Resmini. Supervisor of the thesis “Collective excitations of the charge-density wave state in hydrogen-intercalated $TiSe_2$ probed by ^1H nuclear magnetic resonance” (February 2023).
1. P. Battistoni. Supervisor of the thesis “Low-frequency fluctuations in $LaFeAsO_{1-x}F_x$ iron-based superconductors” (October 2019).

Bachelor in Physics – Università degli Studi di Pavia

5. S. Filippi, supervisor of the thesis "Magnetismo ad alta temperatura in un reticolo metallorganico: uno studio di spettroscopia muonica" (October 2022).
4. E. Brusaschi, supervisor of the thesis "Proton quantification in intercalated $TiSe_2H_x$ using ^1H nuclear magnetic resonance" (March 2022).
3. M. Ragni, supervisor of the thesis "La materia in condizioni estreme: idruri superconduttivi con temperatura critica a 250 K" (June 2020).
2. S. Macedonio, supervisor of the thesis "Proprietà magnetiche del pirocloro $(Eu_{1-x}Bi_x)_2Ir_2O_7$. Uno studio di spettroscopia muonica" (December 2019).
1. A. De Cecco, co-supervisor of the thesis "Studio delle proprietà di materiali superconduttori tramite suscettometro ac basato su SQUID" (October 2011).

Istituto Universitario di Studi Superiori (IUSS) Pavia

1. C. Fruet, supervisor of the thesis "Ultrafast molecular rotors in metal-organic frameworks at cryogenic temperatures" (May 2021).

Internships

2. B. Costarella (from École Normale Supérieure Paris-Saclay, March - July 2023).
1. A. Apaix (from École Normale Supérieure de Lyon, May - July 2022).

Educational activities and dissemination

September 2023	Organizer of the "Low temperature physics" stand at the **European Researchers' Night** – Pavia, Italy.
September 2019	Organizer of the "Low temperature physics" stand at the **European Researchers' Night** – Pavia, Italy.
September 2018	Organizer of the "Low temperature physics" stand at the **European Researchers' Night** – Pavia, Italy.
June 2018	Seminar and lab activities about magnetism and superconductivity in condensed matter within the **Summer Training Course** for 4th-year students of high schools of the province of Pavia (organized by the Department of Physics of the University of Pavia – Pavia, Italy).

Il sottoscritto, consapevole che — ai sensi dell'art. 76 del D.P.R. 445/2000 — le dichiarazioni mendaci, la falsità negli atti e l'uso di atti falsi sono puniti ai sensi del codice penale e delle leggi speciali, dichiara che le informazioni rispondono a verità. Il sottoscritto dichiara di aver ricevuto l'informativa sul trattamento dei dati personali.

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