

# LEONARDO PISANI

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## SUMMARY OF COMPETENCIES AND KEY SKILLS

### Condensed Matter Field Theory, Superconductivity & Ultracold Atomic Gases

- Many-body diagrammatic approaches to Fermi and Bose superfluids
- BCS-BEC crossover within and beyond gaussian fluctuations
- Ultracold atomic gases: Josephson critical current, stability of persistent currents, radio frequency spectra, density profiles and superfluid transition temperature
- Tunnelling spectra of strong coupling unconventional superconductors (granular Aluminium)
- Single- and two-particle dynamical correlators of the homogenous strongly interacting Fermi gas
- Magnetism in carbon-based and metal-organic systems with application in Spintronics
- Phase diagram and long-range order in strongly correlated low dimensional systems

### Density Functional Theory (DFT)

- expertise in DFT within the LAPW (linearised augmented plane wave) basis set and related software WIEN2k (Vienna) and within the Gaussian basis set and related software CRYSTAL (Turin-Daresbury Lab.)
- familiarity with a wide range of exchange-correlation functional (local density (LDA), generalised gradient (GGA, PBE), Hubbard correlation (LDA+U, GGA+U), Hartree-Fock hybrid (B3LYP) )
- calculation of several material properties using DFT: electronic (band) structure, structural optimisation, dynamical forces, magnetic long range order, charge and spin density (Wannier decomposition), phonons (group theory analysis, mode assignment and atomic displacements), spin polarised transport

### Materials Science & Spintronics

- Strongly correlated low dimensional transition metal oxides and anomalous spin-Peierls transition
- Interpretation of ARPES, infrared and Raman spectra in collaboration with experimental groups.
- Design of spintronics devices: dilute magnetic semiconductors with high Curie temperature and metal-organic compounds.
- Ferromagnetic long-range order and spin polarised transport in graphene ribbons
- Room temperature ferromagnetism in defective graphene

### Financial Engineering

- Probability theory, Random walk, Markov chain, Brownian motion, stochastic differential equations and Ito's calculus, local and stochastic volatility models
- Theory of arbitrage pricing, hedging and risk management of standard and exotic derivatives
- Finite difference methods for partial differential equations and Monte-Carlo simulation
- Knowledge of the financial markets and their regulations, particularly foreign exchange

### Banking Business

- Work under pressure for long hours in a fast-paced environment
- Ability to multitask and provide real-time support to the live trading desks
- Efficient collaboration with the information technology (I.T.) and other departments
- Management and coordination of I.T. outsourcing
- Clear, timely reporting and documentation skills
- Team building spirit, openness to constructive criticism from colleagues, strong individual drive, clarity in communication and customer service attitude

### Programming & Numerical Methods

- Development of a multiple-programmer library in C++
- Expertise in object oriented programming (encapsulation, polymorphism, overloading, templating) and memory management
- Knowledge of the principles of software engineering: coding standards, extreme programming, code review, testing, debugging and deployment; automated code revision systems
- Extensive usage of modules and derived data types with Fortran 90/95
- Proficiency in numerical techniques for integration, interpolation, minimisation, sorting, root finding

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## **CAREER HISTORY**

**University of Camerino, Camerino and LENS, University of Florence** **Sep.'21-Sep'23**

*Collaboration (Prof. P. Pieri, Prof. G. C. Strinati, Dr. G. Roati, Prof. G. Deutscher)*

- Josephson critical current and stability of persistent currents in ultracold Fermi gases throughout the BCS-BEC crossover
- Tunnelling spectra and pseudo-gap in unconventional superconductors (granular Aluminium)

**University of Camerino, Camerino, Italy** **Sep.'19-Sep'21**

*Research Fellowship (Prof. P. Pieri and Prof. G. C. Strinati)*

- Off-Diagonal long-range order and coherence lengths in the BCS-BEC crossover
- Radio Frequency Spectroscopy and Bragg Spectroscopy in ultracold Fermi gases

**University of Camerino, Camerino, Italy** **Mar.'17-Mar'19**

*Collaboration (Prof. P. Pieri and Prof. G. C. Strinati)*

- Gorkov-Melik-Barkhudarov corrections to the critical temperature and order parameter of a neutral superfluid Fermi system

**Sabbatical period** **Mar.'13-Sep'16**

- After years of metropolitan living and intense work schedule I decided to retreat to the beautiful landscape of the Nature Reserve of Mount San Vicino, where my late mother came from.
- Collaboration (Jul.'13-Apr.'14) with Prof. T. Maitra (Indian Institute of Technology, Roorkee) on geometrically frustrated magnetic systems with competing orbital degrees of freedom.

**Commerzbank, London** **Mar.'08-Mar'13**

*Financial Engineer*

- Front office role within the foreign exchange (FX) financial engineering team aimed at the development of the pricing (C++) library and live support of structuring, trading and sales desks
- Complete knowledge of FX market conventions and FX volatility surface construction
- Familiar with models of Local Volatility, Local Stochastic Volatility, FX-IR Hybrid and numerical techniques like Monte-Carlo and Finite Difference Methods (generalised Crank-Nicholson)
- Theory of arbitrage pricing, stochastic differential equations and Ito's calculus
- Implemented risk engine for generation of greeks and bid ask prices (C++) across the full range of FX products: options, vanilla strategies, exotic and structured products
- Implemented a consistent framework for the estimation of non-hedgeable risk
- Developed structured and exotic (/// generation) products via the bank proprietary pay-out language, adopting single and multicurrency (local correlation model) frameworks
- Generated analytical solutions for very fast pricing of exotic products
- Validated and tested the FX risk management system
- Integrated risk engine with the parallel computation engine
- Developed interface utilities for the interconnection of the core library with the in-house pricers, volatility management system and e-Commerce
- Coordination of offshore outsourcing of IT development
- Liaised with the onshore IT departments on deployment and maintenance of pricing GUI
- Created a number of multitasking, flexible and user-friendly spreadsheets for the structuring desk via the use of Excel-VBA

**Imperial College London**

Nov.'05-Nov.'07

*Post-doctoral Research Associate (Prof. N. M. Harrison and Dr. B. Montanari)*

- Investigation of possible routes to carbon-based magnetism through large scale simulations and *Density Functional Theory* within the project: European Consortium **FERROCARBON** (<http://www.ferrocarbon.eu>)
- Electronic structure, magnetic long range order and spin dependent transport in graphitic ribbons.
- Room temperature ferromagnetism and spin polarised transport in graphene by means of defects, vacancies and doping
- Room temperature ferromagnetism in metal-organic materials (  $V(\text{TCNE})_2$  )

**J. W. Goethe University, Frankfurt**

Sep.'03-Nov.'05

*Post-doctoral Research Associate (Prof. R. Valenti)*

- Structural, electronic, vibrational and magnetic properties of novel transition-metal oxyhalides via *Density Functional Theory* (relevant to high-temperature superconductivity)
- Anomalous spin-Peierls transition, Raman and infrared phonon spectra and interplay between orbital, lattice, spin degrees of freedom in low dimensional systems
- Interpretation of angle-resolved photoemission spectra in collaboration with Prof. R. Claessen (University of Wuerzburg)
- *First-principles* study of magnetically doped spinel semiconductors (Fe-doped  $\text{ZnGa}_2\text{O}_4$  ) and their possible application to *Spintronics*

**University of Camerino, Camerino, Italy**

Feb.'03-Jul.'03

*Post-doctoral Research Associate (Prof. G. C. Strinati, Prof. P. Pieri and Prof. A. Perali)*

- *BCS-BEC crossover* for a system of trapped Fermi atoms above and below the superfluid critical temperature.

**Military Service, Rome**

Jun.'99-Mar.'00

*Army Corporal***EDUCATION****University of Camerino, Italy**

Apr.'00-Jul.'03

*PhD in Physics (Supervisors: Prof. G. C. Strinati and Prof. P. Pieri)*

- Pairing fluctuation effects on the single-particle photoemission spectra below the superconducting transition temperature across the *BCS-BEC crossover*
- Built, tested and optimised two FORTRAN77 codes to generate the single-particle spectral function and thermodynamic parameters, respectively
- Developed analytical representations of the spectral function in the strong coupling limit as a benchmark for testing and as an aid for the interpretation of experimental spectra
- Comparison of spectral features with angle resolved photoemission spectra of high-temperature superconductors

**University of Bologna, Italy**

Oct.'92- Oct.'98

*Laurea in Physics, final mark: 110/110 cum laude.*

Thesis: "Magnetic Properties of Strongly Correlated Electron Systems".

Last year courses: Quantum Field Theory, Quantum Electrodynamics, General Relativity, Nuclear Physics, Statistical Mechanics, Non-Linear Mechanics

**TECHNICAL SKILLS****Modern languages:** highest-level qualification within Cambridge English Assessment (CEFR C2), Certificate n. 0053370400. Can read German.**Operating Systems:** Linux and Windows.**Development/Productivity Tools:** Mathematica, Microsoft Office applications, Xmgrace, Gnuplot, Latex.

## TEACHING AND SUPERVISING EXPERIENCE

- coordinated project on Josephson critical current and stability of persistent currents involving at first a PhD student then junior post-doctoral researcher (Verdiana Piselli) at the University of Camerino and at LENS in Florence (2021-current)
- contributed to supervise a PhD student (Michele Pini) at the University of Camerino on the study of radio frequency spectra (2019) and of the polaronic limit of the polarized Fermi gas (2022)
- supervision of a PhD student at Imperial College (2006-2007) within the project: "Room temperature ferromagnetism in organic and metal-organic materials"
- supervision of a 3rd year undergraduate student for the Literature B.Sc. projects on Intercalated graphite (March-June 2007) at Imperial College.
- supervision of 3rd year undergraduate student for the Literature B.Sc. projects on Spintronics (January-March 2007).
- Research Masters and 4th year students - Autumn Term 2006, Chemistry Dept. - Lecture on Magnetism and Spin-Density Functional Theory.
- 2nd year Undergraduate - Autumn Term 2006, Chemistry Dept. - Problem Class -Theoretical methods in chemistry: LCAO Theory of Ethene and Butadiene.
- 2nd year Undergraduate - Spring Term 2005, Chemistry Dept. - Computational Laboratory, Module: "The Free Energy and Thermal Expansion of MgO"
- 2nd year Undergraduate - Spring Term 2005, Chemistry Dept. - Problem Class: theoretical methods in chemistry: sequences, series, Morse potential, harmonic approximation, vibrational modes.
- Problems in quantum mechanics at the Institute for Theoretical Physics, Frankfurt am Main (3 rd year Undergraduate, Winter Term 2004)

## SCIENTIFIC VISITS

- CNR-INO and LENS, June 2023, Florence. Discussion over theory and experiment on "*Persistent currents and Landau critical velocity in the BCS-BEC crossover*" in the group of Dr. G. Roati
- CNR-INO and LENS, 21 Oct. 2022, Florence. Invited Talk: "*Spatial emergence of off-diagonal long-range order throughout the BCS-BEC crossover*", hosted by Dr. G. Roati and by CNR-INO Executive Director Prof. Francesco Saverio Cataliotti
- CNR-INO and LENS, June 2022, Florence. Discussion over theory and experiment on the "*Josephson effect in the BCS-BEC crossover*" in the group of Dr. G. Roati

## CONFERENCES and WORKSHOPS

- **ICQSIM 2023**, 13-17 November 2023, Ecole Polytechnique, Palaiseau (Paris). Poster: "*Josephson effect and Landau critical velocity throughout the BCS-BEC crossover in ultracold atomic gases*"
- **Multi-Super 2023**, 8-10 September 2023, University of Camerino. Invited Talk: "*Josephson effect and Landau Critical Velocity throughout the BCS-BEC crossover*"
- **Super-Fluctuations 2017**, 6-8 September 2017, University of Camerino.
- **Condensed Matter and Materials Physics (CMMP07)**, 12 - 13 April 2007, University of Leicester, UK. Poster: "*Ferromagnetism in graphitic ribbons*"
- **Korrelationstage 2007**, 26 Feb.-2 March 2007, Max-Planck-Institut fuer Physik komplexer Systeme, Dresden, Germany. Invited Talk: "*Ab-initio phonons in the Spin-Peierls phase of TiOCl*"
- **Annual IoP Condensed Matter Theory group meeting**, 19 December 2006, University of Warwick. Poster: "*Ferromagnetism in graphitic ribbons*"
- **Computational Magnetism**, 13 December 2006, The Institute of Physics, London.
- **CRIM06: Current research in magnetism 2006**, 8 December 2006, London, Imperial College London.

- **Theoretical and Experimental Magnetism Meeting**, 3-4 August 2006, Cosener's House, Abingdon, UK. Poster: "Ferromagnetism in only-carbon structures".
- **14th European Conference on Mathematics for Industry**, 10-14 July 2006, Madrid. Invited Talk: "Ferromagnetism in graphitic systems".
- **Topics in Nano-Magnetism**, 30 November 2005, Daresbury, UK, organised by Prof. W. Temmerman, Dr W. Hofer, Dr A. Wander and Prof. N. Harrison.
- **Toward atomistic materials design**,  $\Psi$ -k Network Conference, 17-21 September, 2005, Schwaebisch Gmuend, Germany. Poster: "Ab-initio phonons for the layered compound TiOCl".
- **Spring Meeting of the Condensed Matter Division of the German Physical Society (DPG)**, 4-9 March, 2005, Berlin. Poster: "Ab-initio phonons for the layered compound TiOCl".
- **International workshop on Collective quantum states in low-dimensional transition metal oxides**, 22-25 Feb. 2005, Max Planck Institut fuer Physik Komplexer Systeme, Dresden (Germany)
- **Field Theory of Quantum Coherence, Correlations, and Mesoscopic Physics**, III Windsor Summer School, 9-22 August 2004, Windsor (Lancaster University, UK). Poster: "BCS-BEC crossover at finite temperature for superfluid trapped Fermi atoms".
- **XI National School of Physics of Condensed Matter "Stati elettronici in metalli superconduttori"**, Sep. 2000, I.S.I. Foundation (Institute for Scientific Interchange), Villa Gualino, Turin, (Italy).

## PROFESSIONAL QUALIFICATIONS & MEMBERSHIPS

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|------------------------|--|
| <b>Mar.'99-Jun.'99</b> | Qualification to teach Mathematics in Secondary School.  |
| <b>Nov.'05-Nov.'07</b> | Referee of Physical Review B, Referee of Journal of Physics, Member of Institute of Physics, Member of American Physical Society |

## PUBLICATIONS

1. L. Pisani, A. G. Moshe, P. Pieri, G. Calvanese Strinati, G. Deutscher: "**Tunneling spectra of strong coupling unconventional superconductors**", (submitted to PRL)
2. L. Pisani, V. Piselli, G. Calvanese Strinati, "**Critical current throughout the BCS-BEC crossover with the inclusion of pairing fluctuations**", arXiv:2311.00540 (Submitted to Phys. Rev. A)
3. V. Piselli, L. Pisani, G. Calvanese Strinati, "**Inclusion of pairing fluctuations in a semiclassical approach: The case of study of the Josephson effect**", European Physics Journal A (to be published)
4. L. Pisani, M. Pini, P. Pieri, G. C. Strinati, "**Peaks and widths of radio-frequency spectra: An analysis of the phase diagram of ultra-cold Fermi gases**", Results in Physics **57**, 107358 (2024)
5. V. Piselli, L. Pisani, G. Calvanese Strinati, "**Josephson current flowing through a nontrivial geometry: The role of pairing fluctuations across the BCS-BEC crossover**", Phys. Rev. B **108**, 214504 (2023)
6. L. Pisani, V. Piselli, G. Calvanese Strinati, "**Inclusion of pairing fluctuations in the differential equation for the gap parameter for superfluid fermions in the presence of nontrivial spatial constraints**", Phys. Rev. B **108**, 214503 (2023)
7. L. Pisani, P. Pieri, G. Calvanese Strinati, "**Spatial emergence of off-diagonal long range order throughout the BCS-BEC crossover**", Phys. Rev. B **105**, 054505 (2022)
8. L. Pisani, P. Pieri, G. Calvanese Strinati, "**Gap equation with pairing correlations beyond mean field and its equivalence to a Hugenholtz-Pines condition for fermion pairs**", Phys. Rev. B **98**, 104507 (2018)

9. L. Pisani, A. Perali, P. Pieri, G. Calvanese Strinati, "**Entanglement between pairing and screening in the Gorkov-Melik-Barkhudarov correction to the critical temperature throughout the BCS-BEC crossover**", Phys. Rev. B **97**, 014528 (2018)
10. M. Dhariwal, L. Pisani, T. Maitra, "**Competing electronic states in high temperature phase of NaTiO(2)**", J. Phys.: Condensed Matter **26**, 205501 (2014)
11. L. Pisani, B. Montanari, N. H. Harrison, "**Stability of the ferromagnetic state in a mixed sp<sup>2</sup>-sp<sup>3</sup> carbon system**", Phys. Rev. B **80**, 104415 (2009)
12. G. C. de Fusco, L. Pisani, B. Montanari, N. H. Harrison, "**Density functional study of the magnetic coupling in V(TCNE)-2**", Phys. Rev. B **79**, 8 (2009)
13. L. Pisani, B. Montanari, N. H. Harrison, "**A defective graphene phase predicted to be a room temperature ferromagnetic semiconductor**", New Journal of Physics **10**, 033002 (2008).
14. L. Pisani, R. Valenti, B. Montanari and N. M. Harrison, "**Density functional study of the electronic and vibrational properties of TiOCl**", Phys. Rev. B **76**, 235126 (2007)
15. M. Hoinkis, M. Sing, S. Glawion, L. Pisani, R. Valenti, S. van Smaalen, M. Klemm, S. Horn, and R. Claessen, "**One-dimensional versus two-dimensional correlation effects in the oxyhalides TiOCl and TiOBr**", Phys. Rev. B **75**, 245124 (2007)
16. L. Pisani, J. A. Chan, B. Montanari, N. H. Harrison, "**Electronic structure and magnetic properties of graphitic ribbons**", Phys. Rev. B. **75**, 064418 (2007)
17. L. Pisani, T. Maitra, and R. Valenti: "**Effects of Fe substitution on the electronic, transport, and magnetic properties of ZnGa<sub>2</sub>O<sub>4</sub>: A systematic ab-initio study**", Phys. Rev. B **73**, 205204 (2006)
18. M. Sing, M. Hoinkis, J. Schaefer, M. Klemm, S. Horn, H. Benthien, E. Jeckelmann, L. Pisani, R. Valenti, and R. Claessen: "**Electronic structure and fluctuation effects in the spin-1/2 quantum magnet TiOCl**", J. de Physique IV **131**, 331 (2005)
19. M. Hoinkis, M. Sing, J. Schaefer, M. Klemm, S. Horn, H. Benthien, E. Jeckelmann, T. Saha-Dasgupta, L. Pisani, R. Valenti, and R. Claessen: "**Electronic structure of the spin-1/2 quantum magnet TiOCl**", Phys. Rev. B **72**, 125127 (2005)
20. P. Pieri, L. Pisani, and G. C. Strinati: "**Comparison between a diagrammatic theory for the BCS-BEC crossover and quantum Monte Carlo results**", Phys. Rev. B **73**, 0125127 (2005)
21. L. Pisani and R. Valenti: "**Ab initio phonon calculations for the layered compound TiOCl**", Phys. Rev. B **71**, 180409(R) (2005)
22. A. Perali, P. Pieri, L. Pisani, and G. C. Strinati: "**BCS-BEC Crossover at Finite Temperature for Superfluid Trapped Fermi Atoms**", Phys. Rev. Lett. **92**, 220404 (2004)
23. P. Pieri, L. Pisani, G. C. Strinati and A. Perali: "**Single-particle spectra and magnetic field effects within precursor superconductivity**", PHYSICA C **408**, 317 (2004)
24. P. Pieri, L. Pisani, and G. C. Strinati: "**Pairing Fluctuation Effects on the Single-Particle Spectra for the Superconducting State**", Phys. Rev. Lett. **92**, 110401 (2004)
25. P. Pieri, L. Pisani, and G. C. Strinati: "**BCS-BEC crossover at finite temperature in the broken-symmetry phase**", Phys. Rev. B **70**, 094508 (2004)
26. E. Ercolessi., G. Morandi, L. Pisani and M. Roncaglia: "**Mixed phases for the t-J model**", PHYSICA C **331**, 178 (2000)