

Ettore Vitali

Curriculum Vitae



Place and Date of Birth: Vaprio
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Academic Appointments and Research Experience

- From August 2018 **Assistant Professor of Physics**, California State University Fresno, Fresno, California, United States.
- April 2015- July 2018 **Postdoctoral Research Associate**, Computational Materials Group, Physics Department, **College of William and Mary**, Williamsburg, Virginia, United States.
- April 2011-March 2015 **Post Doc fellowship** (Assegno di collaborazione alla Ricerca) at the **Università degli Studi di Milano** (Italy)
- April 2009-March 2011 **Post Doc fellowship** (Assegno di collaborazione alla Ricerca) at the **Centros di Ricerca e Sviluppo DEMOCRITOS**, CNR-INFN at Trieste (Italy),

Education and Training

- 22 Dec 2008 **PhD in Physics, Astrophysics and Applied Physics** (Dottorato di Ricerca in Fisica, Astrofisica e Fisica Applicata), at the **Università degli Studi di Milano** (Italy) under the supervision of Prof. Luciano Reatto and Prof. Ludovico Lanz; thesis title “Superfluid and supersolid phases of ^4He ”.
- 2005 **Fellowship for the training of young students** (borsa per la formazione dei giovani piu' promettenti), at the **Università degli Studi di Milano** (Italy) in the project “Quantum Relativistic Theory of Open Systems”, superintendent Prof. Ludovico Lanz.
- 8 Feb 2005 **Master Degree in Physics** (Summa cum laude) at the **Università degli Studi di Milano** (Italy) under the supervision of Prof. Ludovico Lanz; thesis title “Fluid dynamics in the realm of non-relativistic quantum non-equilibrium theory”.
- 7 July 2000 **Classic Diploma** (100/100), High School Istituto Leone XIII, Milano (MI), Italy.

Teaching Experience

Courses

- 2012-2014 **Lecturer** of the course “*Computational Physics*” (30 hours) (three consecutive editions) at the Doctorate School in Physics Astrophysics and Applied Physics at the **Universita' Degli Studi di Milano** (Italy). **PhD level**. The course dealt with the foundations of stochastic calculus and numerical simulations. The lecture notes of the course are becoming a book, that will be published by Springer Unitext.
- 2012 **Assistant Lecturer** of the course “*Physics*” (25 hours) for Agricultural Science and Technology at the **Universita' Degli Studi di Milano** (Italy). **Undergraduate level**.
- 2011 **Co-Lecturer** of the course “*Computational Physics*” (15 hours) at the Doctorate School in Physics, Astrophysics and Applied Physics at the **Universita' Degli Studi di Milano** (Italy). **PhD level**.
- During PhD
(2005-2008) **Tutor** of the courses “*Quantum Mechanics I*” (from AY 2005/06 to AY 2007/08) and “*Structure of Matter*” (AY 2007/08) at the **Universita' Degli Studi di Milano** (Italy). **Undergraduate level**. **Assistant Lecturer** of the course “*Physics*” for Biotechnology at the **Universita' Degli Studi di Milano** (Italy). **Undergraduate level**.

Student support and advising

- 2015-2017 Advising and mentoring for the master degree research projects of Mr. Peter Rosenberg, Mr. Adam Chichak and Mr. Joseph Cuozzo. College William and Mary
- 2016 Vice-Supervisor of the Master thesis “*Stochastic Models for self-organized criticality in financial Markets*”. Università degli Studi di Milano.
- 2015 Vice-Supervisor of the Bachelor thesis “*Analisi storica della correlazione istantanea tra processi stocastici*” (*Analysis of instantaneous correlations among stochastic processes*). Università degli Studi di Milano.
- 2012 Vice-Supervisor of the Bachelor thesis “*Ab-initio low energy dynamics of two-dimensional superfluid 4He* ”. Università degli Studi di Milano.
- 2012 Vice-Supervisor of the Master thesis “*Auxiliary Fields Quantum Monte Carlo: application to the two-dimensional electron gas*”. Università degli Studi di Milano.

Awards

- 2011 Award of excellence: the project “*First principle methodologies for the study of static and transport properties in quantum systems of condensed matter and ultracold gases*” has been considered in the 10% of the best projects presented in the contest for the conferment of 100 Post-Doc fellowships published on 16 June 2010.

Publications

Books

“*Theory and simulation of random phenomena*”, in collaboration with M. Motta and D.E. Galli. Springer Unitext, ISBN 978-3-319-90514-3 (2018).
<https://www.springer.com/us/book/9783319905143>

Review papers

“*Statistical and computational intelligence approach to analytic continuation in Quantum Monte Carlo*”, G. Bertaina, D. E. Galli, and E. Vitali, *Advances in Physics X* 2, 302 (2017).

Journal articles

“*Magnetic orders in the hole-doped three-band Hubbard model: Spin spirals, nematicity, and ferromagnetic domain*”, A. Chiaciak, E. Vitali, H. Shi, and S. Zhang, *Phys. Rev. B* 97, 235127 (2018)

“*Visualizing the BEC-BCS crossover in a two-dimensional Fermi gas: Pairing gaps and dynamical response functions from ab-initio computations*”, E. Vitali, H. Shi, M. Qin, and S. Zhang, *Phys. Rev. A* 96, 061601(R) (2017).

“*Response functions for the two-dimensional ultracold Fermi gas: dynamical BCS theory and beyond*”, E. Vitali, H. Shi, M. Qin, and S. Zhang, *Journal of Low Temperature Physics*, 189, 312 (2017).

“*Computation of dynamical correlation functions for many-fermion systems with auxiliary-field quantum Monte Carlo*”, E. Vitali, H. Shi, M. Qin, and S. Zhang, *Phys. Rev. B*, 94, 085140 (2016) (Editor’s suggestion).

“*One-dimensional liquid ⁴He: dynamical properties beyond Luttinger-liquid theory*”, G. Bertaina, M. Motta, M. Rossi, E. Vitali, and D.E. Galli, *Phys. Rev. Lett.* 116, 135302 (2016).

“*Dynamical structure factor of one-dimensional hard rods*”, M. Motta, E. Vitali, M. Rossi, D.E. Galli, and G. Bertaina, *Phys. Rev. A*, 94, 043627 (2016).

“*Low-density phases of ³He monolayers adsorbed on graphite*”, M. Ruggeri, E. Vitali, D.E. Galli, M. Boninsegni, and S. Moroni, *Phys. Rev. B* 93, 104102 (2016).

“*Linear response of one-dimensional liquid ⁴He to external perturbations*”, M. Motta, G.

Bertaina, E. Vitali, D. E. Galli, and M. Rossi, *J. Low. Temp. Phys.*, 10.1007/s10909-016-1704-8 (2016).

“*Imaginary Time Density-Density Correlations for two-dimensional Electron Gases at High Density*”, M. Motta, D.E. Galli, S. Moroni, and E. Vitali, *J. Chem. Phys*, 143, 164108 (2015).

“*Implementation of the linear method for the optimization of Jastrow-Feenberg and backflow correlations*”, M. Motta, G. Bertaina, D.E. Galli, and E. Vitali, *Comp. Phys. Comm.*, 190, 62 (2015).

“*Imaginary time correlations and the phaseless auxiliary field quantum Monte Carlo*”, M. Motta, D.E. Galli, S. Moroni, and E. Vitali, *J. Chem. Phys.* 140, 024107 (2014).

“*Excitation spectrum in two-dimensional superfluid ^4He* ”, F. Arrigoni, E. Vitali, D.E. Galli, L. Reatto, *Low Temp. Phys./Fizika Nizkikh Temperatur*, 39 1021 (2013).

“*Dynamic structure factor for ^3He in two dimensions*”, M. Nava, D.E. Galli, S. Moroni, and E. Vitali, *Phys. Rev. B* 87, 144506 (2013).

“*Equation of state of two-dimensional ^3He at zero temperature*” M. Nava, A. Motta, D.E. Galli, E. Vitali, and S. Moroni, *Phys. Rev. B* 85, 184401 (2012).

“*Microscopic characterization of overpressurized superfluid ^4He* ”, M. Rossi, E. Vitali, L. Reatto, D.E. Galli, *Phys. Rev. B* 85, 014525 (2012).

“*Bose soft discs: a minimal model for supersolidity*” S. Saccani, S. Moroni, E. Vitali and M. Boninsegni, *Mol. Phys.* 109, 2807 (2011).

“*Long-range correlations in quantum solids*”, E. Vitali, P. Arrighetti, M. Rossi, and D.E. Galli, *Mol. Phys.* 109, 2855 (2011).

“*Ab initio low-energy dynamics of superfluid and solid ^4He* ”, E. Vitali, M. Rossi, L. Reatto, and D.E. Galli, *Phys. Rev. B* 82, 174510 (2010).

“*Quantum dislocations: the fate of multiple vacancies in two-dimensional solid ^4He* ”, M. Rossi, E. Vitali, D.E. Galli, and L. Reatto, *J. of Phys.: Condensed Matter* 22, 145401 (2010).

“*Zero-Point Vacancies in Quantum Solids*”, M. Rossi, E. Vitali, D.E. Galli, and L. Reatto, *J. Low Temp. Phys.* 153, 250 (2008).

“*Path Integral ground state study of two-dimensional solid ^4He* ”, E. Vitali, M. Rossi, F. Tramonto, D.E. Galli, and L. Reatto, *Phys. Rev. B* 77, 180505(R) (2008).

Manuscripts submitted or in preparation

“*Metal-insulator transition in the ground-state of the three-band Hubbard model at half-filling*”, E. Vitali, H. Shi, A. Chiciak, and S. Zhang, in preparation, to be submitted

to Physical Review Letters.

Peer-reviewed Conference Proceedings

“Zero-temperature study of vacancies in solid 4He”, M. Rossi, E. Vitali, D.E. Galli and L. Reatto, J. Phys.: Conference Series 150, 032090 (2009).

“Real time dynamics from quantum Monte Carlo data: A genetic algorithm approach”, E. Vitali, D.E. Galli and L. Reatto, J. Phys.: Conference Series 150, 032116 (2009).

“Microscopic Studies of Solid 4He with Path Integral Projector Monte Carlo”, M. Rossi, R. Rota, E. Vitali, D.E. Galli, and L. Reatto, Series on Advances in Quantum Many Body Theory, Vol.11, pp. 300-311 (World Scientific, 2008).

“Liquid-solid transition in Bose systems at $T=0$ K: Analytic results about the ground state wave function”, E. Vitali, D.E. Galli, and L. Reatto, Series on Advances in Quantum Many Body Theory, Vol.11, pp. 251-254 (World Scientific, 2008).

Conference Papers & Contributions to Books

“The Shadow Path integral Ground State method: New light into the Physics of Quantum Solids”, E. Vitali, D.E. Galli and L. Reatto, Research Activities on High Performance Computing Clusters at CILEA 2006, edited by CILEA (2007), ISBN 978-88-88971-12-4.

Conference Presentations

Invited talks

- *“Computational Physics: from Random Walks to Strongly Correlated Systems”*, Colloquium as a Candidate for Assistant Professor Position, California State University, Fresno, CA (USA), (2018).
- *“Exact numerical results on the pairing gap, spectral function and dynamical response in the two-dimensional Fermi gas”*, at the ECT* workshop *“Superfluidity and Pairing Phenomena: from cold atomic gases to neutron stars”*, Trento (ITA), (2017).
- *“Computation of dynamical correlation functions for many-fermion systems with auxiliary-field quantum Monte Carlo”*, at the Stony Brook summer school of the Simons Foundation, Stony Brook, NY (USA). (2016)
- *“Dynamical imaginary time correlations from auxiliary fields Quantum Monte Carlo”*, at the *“INT Program: Advances in Quantum Monte Carlo Techniques for non-relativistic many-body systems”*, Seattle (USA). (2013)

Contributed talks

- *“Quantum Monte Carlo Calculations for the Ground State of the three-band Hubbard model”*, at the APS March Meeting, Los Angeles (USA). (2018)

- “Ground state properties of the three-band Hubbard model”, at the the Stony Brook summer school of the Simons Foundation, Stony Brook, NY (USA). (2017)
- “Ground state properties of the three-band Hubbard model”, at the APS March Meeting, New Orleans (USA). (2017)
- “Ab initio pairing gap, spectral and response functions of two-dimensional ultracold fermionic gases”, at the APS March Meeting, New Orleans (USA). (2017)
- “Ab-initio Dynamical Correlations from Auxiliary-field Quantum Monte Carlo: applications in the Hubbard model”, at the APS March Meeting , Baltimore (USA). (2016)
- “Dynamical Imaginary Time Correlations from Auxiliary-filed Quantum Monte Carlo”, at the Workshop of the group Physics of Condensed Matter, Milano (IT). (2013)
- “Inverse Problems: Ill-posed Integral Equations. The Genetic Inversion via Falsification of Theories Method”, at the Workshop of the group Physics of Complex Systems, Milano (IT). (2013)
- “Novel Quantum Monte Carlo techniques for the study of dynamical properties of many-body Fermi systems”, at the “XVII National meeting on Statistical Physics and Complex systems” Parma (IT). (2012)
- “Liquid-solid transition in 4He at zero temperature: analytic results about the ground state wave function”, at the “International Conference on Recent Progress in Many-Body Theories” (RPMBT14), Barcelona (ES). (2007)

Posters

- “Ground State of the three-band Hubbard model at half-filling”, at the “2016 Many Electron annual meeting”, New York (USA) (2018).
- “Dynamical Correlations from Auxiliary-Field Quantum Monte Carlo”, at the AFQMC workshop, Flatiron Institute CCQ, New York (USA) (2018).
- “Pairing gap, spectral function, and response functions of two-dimensional cold fermionic gases”, at the “2016 Many Electron annual meeting”, New York (USA) (2017).
- “Dynamical correlations from Quantum Monte Carlo”, at the “2016 Many Electron annual meeting”, New York (USA), (2016).
- “Fermionic correlations: ground state and dynamical properties of two dimensional 3He” at the “XVII National meeting on Statistical Physics and Complex systems” Parma (IT), (2012)
- “Inverse problems: can we obtain more? The Genetic Inversion via Falsification of Theories (GIFT) method, quantum dynamics and the 4He case” at the “XIV National meeting on Statistical Physics and Complex systems” Parma (IT), (2009).
- “Convergence properties of Path-Integral projector Monte Carlo Methods” at the “Mini Workshop on Quantum Monte Carlo Methods”, Sardagna (Trento, IT), (2009)
- “Dynamics from Quantum Monte Carlo data: a genetic algorithm approach” at the “Mini Workshop on Quantum Monte Carlo Methods”, Sardagna (Trento, IT), (2008).
- “Dynamics from Quantum Monte Carlo data: a genetic algorithm approach” at the “25th International Conference on Low Temperature Physics” (LT25), Amsterdam (HO), (2008).

Research and Computational Projects & Grants

2017

Co-Principal Investigator. XSEDE Research allocation for the XSEDE research request: “Competing phases and superconductivity in Hubbard models and exotic states in two-dimensional ultracold atoms: an

auxiliary-field quantum monte carlo study”. Resources awarded equivalent to \$157085.37 US dollars.

- 2016 **Co-Principal Investigator.** XSEDE Research allocation for the XSEDE research request: “Competing phases and superconductivity in the Hubbard model and excited states of the two-dimensional Fermi gas: an auxiliary-field quantum monte carlo study”. Resources awarded equivalent to 149115.16 US dollars.
- 2015 **Co-Principal Investigator.** XSEDE Research allocation for the XSEDE research request: “Competing phases and superconductivity in the Hubbard model and spin-orbit coupling in the two-dimensional Fermi gas: an auxiliary-field quantum monte carlo study”. Resources awarded equivalent to 111765.51 US dollars
- 2014 Regione Lombardia and CINECA Consortium through a LISA Initiative (Laboratory for Interdisciplinary Advanced Simulation) Grant: “Ultracold gases, liquids and solids via Quantum Monte Carlo (UltraQMC), 3.000.000 CPU hours
- 2013 Regione Lombardia and CINECA Consortium through a LISA Initiative (Laboratory for Interdisciplinary Advanced Simulation) Grant: “Fermionic Dynamics on Fermi (FDF)”, 2.400.000 CPU hours
- 2013 Regione Lombardia and CINECA Consortium through a LISA Initiative (Laboratory for Interdisciplinary Advanced Simulation) Development Grant: “Fermionic Dynamics on Fermi (FDF)”, 100.000 CPU hours
- 2013 Regione Lombardia and CINECA Consortium through a LISA Initiative (Laboratory for Interdisciplinary Advanced Simulation) Grant: “Structure and Dynamics via Inverse Problems (SDVIP), 1.232.000 CPU hours

Memberships and Affiliations

- 2016-today **American Physical Society**
- 2015-today **Simons Foundation: The Simons Collaboration on the Many Electron Problem.**

Research Interests

- Condensed matter Physics and Quantum Gases: models to understand high T_c superconductivity, physics of Fermi ultracold gases, electronic systems, superfluids and low dimensional quantum systems. Ab-initio studies of equilibrium properties and dynamical response functions. Theoretical and computational approaches to quantum many-body systems.
- Probability theory, stochastic processes, stochastic differential equations and numerical simulation techniques, in particular Quantum Monte Carlo, both in the configurational space and in the Slater determinants manifolds.
- Statistical methods for ill-posed inverse problems, with applications to the study of dynamical properties of many-body quantum systems via Quantum Monte Carlo simulations.

Current Activities

- Single and multiband Hubbard model for high T_c superconductors. I am performing an extensive determinantal Quantum Monte Carlo study. The purpose is the characterization of the ground state wave function of the models, in connection with the physics of high temperature superconductors: charge and spin order, as well as pairing correlations are under study. Moreover, I study dynamical correlation functions as a tool to explore the manifold of excited states.
- Physics of Fermi cold gases, in the strongly correlated regime. With auxiliary-field Quantum Monte Carlo methods it is possible to compute exact properties of those systems, which is a unique possibility in the realm of strongly correlated quantum many body systems. I study dilute cold gases in the BEC-BSC crossover, cold atoms on optical lattices, as well as systems with spin-orbit coupling and spin imbalance. In particular, I study dynamical response functions, and investigate possibilities to have access to real time dynamics of those systems.

Scientific Skills

- Quantum Monte Carlo simulations.
- Analytic continuation methods.
- Many-body theory, Statistical Physics, Quantum Field theory and Mathematical Physics.
- Probability Theory, Stochastic Processes and Statistical analysis.
- Monte Carlo and Molecular Dynamics techniques.

Other Skills

- Programming ability in Fortran, C++, C, Python and Julia. Parallel programming: MPI. Graphical tools: Gnuplot, Python and Asymptote
- Spoken languages: Italian, English
- Good communication, teaching and advising skills
- Positive attitude and enthusiasm in facing new challenges in research, and in developing innovative algorithms

References

Shiwei Zhang
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Saverio Moroni

Scuola Internazionale Superiore di Studi Avanzati (SISSA) and CNR-IOM DEMOCRITOS Simulation Center, Via Bonomea 265, 34136 Trieste ITALY

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