

Sebastiano Pilati

CURRICULUM VITAE

Current research position:

- *Since 01/2017* **Research Fellow** (Assegnista di Ricerca)
University of Padua

Previous research positions:

- *09/2011 – 12/2016* **Long Term Visiting Scientist (Boltzmann Fellow)**
UNESCO/IAEA International Centre for Theoretical Physics (ICTP), Trieste (Italy)
- *09/2009 – 08/2011* **Postdoctoral Fellow**, ETH – Swiss Federal Institute of Technology, Zurich
Computational Physics group lead by Prof. M. Troyer.
- *03/2008 – 08/2009* **Postdoctoral Fellow** (Assegnista di Ricerca), INO-CNR “BEC Centre” - Trento

Further research experiences:

- *09/2004 – 08/2005* Visiting Graduate Student in the group of Prof. J. Boronat, Polytechnic University of Catalunya, Barcelona (Spain).
- *03/2004 - 09/2004* Post-Lauream Fellowship of INFN - Istituto Nazionale di Fisica della Materia, Unità di Ricerca di Trento

Education:

- *08/2004 – 02/2008* **Ph.D. Degree in Physics** at the University of Trento (28/02/2008)
Title: “*Studies of Ultracold Gases using Quantum Monte Carlo techniques*”
Supervisor: Prof. S. Giorgini Evaluation: *excellent*.
- *02/2004* **Laurea in Physics** at the University of Trento (18/02/2004)
Title: “*Quantum Monte Carlo study of the ground-state properties of a two dimensional Bose gas*”
Evaluation: *110/110 cum Laude* Average exams grade: *29.7/30*

My research interests / achievements

My research activity is mainly devoted to the study of ultracold atomic gases via computer simulations. The long-term goal is to improve beyond the state-of-the-art the theoretical and computational techniques for quantum many-body systems and to guide the engineering of novel phases of quantum matter and of novel quantum technologies. In recent years, I have given a relevant important contribution to the development of innovative computational methods based on quantum Monte Carlo algorithms. Thanks to these advancements, it is now possible to perform accurate computer simulations of complex quantum systems using realistic models that take into account the details of actual experimental configurations (e.g., the structure of the spatial correlations of the disorder); this has allowed us to shed light on various intriguing quantum phenomena and to provide quantitative predictions that have been confirmed by cold-atoms experiments (e.g., the phase separation in polarized Fermi gases in the BEC-BCS crossover, or the onset of Stoner ferromagnetism in repulsive Fermi gases), leading to various publications in journals with high impact factor (e.g., Physical Review Letter and Nature Physics). My most relevant achievements are related to the combined effect of interactions, disorder, and of optical lattices on the superfluid transition in Bose gases (see publications 5, 6, 8, 11, and 14 in publication list), to the breakdown of superfluidity in polarized Fermi (see publications 4 and 10), to quantum magnetism in clean and in disordered Fermi gases (see publications 9, 12, 13, 15, and 20), and to the Anderson localization in correlated disordered fields (see publications 16, 19). We also developed an energy-density functional for ultracold Fermi gases in external potentials which allows one to exploit the power of density functional theory to simulate quantum gases (see publication 12). Many of these results have been used as a stringent benchmark for experiments performed by leading experimental groups, e.g., in the groups lead by C. Salomon at ENS (Paris), by W. Ketterle and M. Zwierlein at MIT, by R. Hulet in Houston, and by M. Inguscio at LENS (Florence). More recently, we published important results in the field of adiabatic quantum

computing (see publication 18), where we use stochastic algorithms to inspect the potential efficiency of quantum annealers (such as the devices commercialized by D-Wave Systems inc. www.dwavesys.com), which are special-purpose quantum computers designed to solve complex optimization problems exploiting quantum fluctuations. It is easy to foresee that this research line will be a hot topic in the near future, with important potential technological applications in the field of machine learning.

I have long standing collaborations with worldwide leading theoretical physicists, in particular with Prof. M. Troyer at ETH, Zurich (where I worked as a Postdoctoral fellow, participating in the “*Optical Lattice Emulator*” Program funded by the US agency DARPA, for which I gave presentations in the review meetings held in Texas and in Colorado), with Nikolay Prokofev from the University of Massachusetts (with whom I collaborate since he spent a sabbatical period at the BEC Center, where I was a graduate student), with Jordi Boronat from UPC in Barcelona (where I spent one year as a visiting graduate student), with the researchers of the BEC Center in Trento, of the Condensed Matter and Statistical Physics Section of the ICTP (Trieste), and with Prof. Salasnich, Ancilotto and Dell’Anna (UNIPD).

I have already experience with the supervision of Diploma and PhD students, and in the collaboration with junior postdoctoral fellows; these collaborations, in which I acted as PI, resulted in publications in journals with high impact factor: Physical Review Letters (see publications 14), Physical Review A (see publications 15, 16, 19, 20 and 22), Physical Review B (see publications 17 and 21), and Physical Review E (see publication 18).

I taught courses both at the undergraduate and graduate levels, and also for the Master in High Performance Computing.

Main on-going research projects - Collaborations:

- Localization of disordered and interacting quantum systems in the framework of the modern theory of the insulating state and of quantum chaos theory – with R. Fazio (ICTP), V.K. Varma (ICTP), E. Fratini (ICTP), E. M. Inack (SISSA).
- Adiabatic quantum computation and Quantum Annealing (testing quantum annealers using stochastic simulations on classical computers, Rényi entropy calculations) – with G. Santoro (SISSA), G. Mossi (SISSA), and A. Scardicchio (ICTP), E. M. Inack (SISSA), R. Fazio (ICTP).
- Quantum Monte Carlo simulations of Interacting Fermions (antiferromagnetism, disorder-induced ferromagnetism, many-body localization) – V. K. Varma (ICTP), L. Dell’Anna (U. Padua), R. Fazio (ICTP).
- Dynamics of interacting quantum systems via density functional theory – with F. Ancilotto (UNIPD).

Supervision of Students / Postdoctoral Fellows:

- Supervisor of 6 students of the Postgraduate Diploma Program in Condensed Matter Physics at ICTP (<https://diploma.ictp.it>).
- Supervisor of 1 graduate student (SISSA, Trieste) http://www.statphys.sissa.it/wordpress/?page_id=2398
- Co-supervisor of 1 Master Student of the Master in *High Performance Computing* <http://www.mhpc.it/>.
- Advisor of 2 Junior Postdoctoral fellows at ICTP.
- Referee and external jury member of 2 PhD theses in SISSA, Trieste, and 1 PhD thesis at EPFL (Lausanne).
- Supervisor for semester projects and physics pro-seminars at ETHZ (2009-2011).

Institutional responsibilities:

- Responsible for the Courses on Monte Carlo methods in the SISSA-ICTP Master in *High Performance Computing*.
- Member of the selection Committee of the ICTP Associate Program (years 2012-2016).
- Member of the selection Committee of the ICTP Long Term Visitors Program (years 2012-2016).
- Member of the selection Committee of the ICTP Postdoctoral Fellows (years 2012-2016).
- Jury member for selection of Ph.D. students at SISSA (years 2012-2016).

Organization of activities (Conferences, Workshops, Schools, Seminar Series):

- Co-organizer of the Workshop on “Understanding Quantum Phenomena with Path Integrals: From Chemical Systems to Quantum fluids and Solids”, to be held from 3 to 7 July 2017 – Trieste (<http://indico.ictp.it/event/7975/>).
- Co-organizer of the Workshop “*Theory and Practice of Adiabatic Quantum Computers and Quantum Simulation*”, 22-26 August 2016 – Trieste (<http://indico.ictp.it/event/7607/>).
- Co-organizer of the Summer School “*Computational Condensed Matter Physics: from Atomistic Simulations to Universal Model Hamiltonians*”, 7-25 September 2015 – Trieste (<http://indico.ictp.it/event/a14246/>)
- Co-organizer of the workshop titled “*Probing and understanding exotic superconductors and superfluids*”, 27-31 October 2014 – Trieste (<http://indico.ictp.it/event/a13228> <https://exs2014.wordpress.com/>)
- Co-organizer of the weakly Seminar Series on “*Disorder and Strong Electron Correlations*” at ICTP, 2012-2104
- Co-organizer of the bi-weakly Seminar Series on “*Condensed Matter and Statistical Physics*” at ICTP, since 01/2016
- Co-organizer of the session on “*Ultracold Atoms and Photonics*” of the XCIX Congress of the Italian Physical Society in 2013, 23 – 27 September, Trieste (<http://www.sif.it/attivita/congresso/xcix>).
- Co-organizer of the XXIV Congress of the Italian National Institute of Matter Physics, 17-20 September 2006, Levico – Trento (<http://bec.science.unitn.it/levico/>).

Third party funding:

- I obtained funds from the international institute ICAM (<http://icam-i2cam.org/>) as contribution for the Workshop “*Probing and understanding exotic superconductors and superfluids*”, 27-31 October 2014.
- I obtained funds from the international institute ICAM (<http://icam-i2cam.org/>) as contribution for the Workshop “*Theory and Practice of Adiabatic Quantum Computers and Quantum Simulation*”, to be held in 22-26 August 2016 – Trieste.

- I obtained funds from the international institute Psi-k (<http://psi-k.net>) as contribution for the Workshop “*Theory and Practice of Adiabatic Quantum Computers and Quantum Simulation*”, to be held in 22-26 August 2016 – Trieste.
- Through the co-organizers, we secured funds for workshops and summer schools from various institutes/agencies, including DFG, CECAM, CNR, and ERC grants.

Teaching:

- Master in High Performance Computing (www.mhpc.it), module on “*Monte Carlo Methods*”, SISSA-ICTP – Trieste, years 2014-2016
- Course “*Numerical and Monte Carlo methods*”, Ph.D. Program in Statistical Physics, SISSA (Trieste), years 2011-2016 (http://www.statphys.sissa.it/wordpress/?page_id=303)
- Course “*Numerical Methods I*”, in the Graduate Diploma Programs in “Condensed Matter Physics” and “Earth System Physics” at ICTP, and for the “International Master in Complex Systems” (SISSA, Politecnico di Torino, Paris 6-7-11 and École Normale Supérieure), years 2012-2016 (<http://diploma.ictp.it/courses/cmisp.aspx>).
- Course “*Numerical Methods II*”, in the Graduate Diploma Program in Condensed Matter Physics at ICTP, 2011-2016 (<http://diploma.ictp.it/courses/cmisp.aspx>).
- Tutor during the ICTP Summer School on “*Quantum Many-Body Physics of Ultracold Atoms and Molecules*”, 2-13 July 2013, Trieste (Italy).
- Lectures in the course “*Computational Quantum Physics*” by Prof. M. Troyer at ETHZ in 2009-2011.
- Teaching assistant for the course on electromagnetism (UniTN, a.y. 2006/2007).

Refereeing:

- Physical Review A and Physical Review Letters (published by the American Physical Society).
- The New Journal of Physics, Journal of Physics A: Mathematical and Theoretical and Journal of Physics B: Atomic, Molecular & Optical Physics (published by the Institute of Physics).
- The European Physical Journal (published by EDP Sciences, Società Italiana di Fisica and Springer).
- Journal of Statistical Mechanics: theory and experiment (published by IOP and SISSA).

Invited talks:

- Many-body Physics in Synthetic Quantum Systems, Stellenbosch, South Africa, 4-8 April 2016
- XVIII International Conference on Recent Progress in Many-Body Theories, 16-21 August 2015.
- MULTISUPER 2014. International Conference on “Multicondensate Superconductivity and Superfluidity in Solids and Ultracold Gases”, 24-27 June 2014, Camerino (Italy).
- Workshop “Correlation in Ultracold Atomic Gases”, 26-27 September 2013, Padova (Italy)
- Conference “Quantum Technologies IV”, 15-20 September 2013, Warsaw (Poland)
- INT Program “Advances in QMC techniques”, 24 June -2 August 2013, Seattle (USA)
- CECAM Workshop on “Modeling Materials With Cold Gases Through Simulations”, 9-11 November 2011, Zurich (Switzerland)
- Workshop “Correlations in Quantum Gases”, 30 September-2 October 2010, Menorca (Spain)
- International Workshop: “Theory of Quantum Gases and Quantum Coherence” 2-4 June 2010, Nice
- Workshop on Quantum Monte Carlo techniques, 29 November 2008, Sardinia (Italy)

Contributed talks:

- Adiabatic Quantum Computing 2015, 29 June – 2 July – Zurich (Switzerland)
- DAMOP Meeting, 25-29 May 2015, 8-12 June - Columbus (Ohio-USA)
- International Conference MBT17, 8-13 September 2013, Rostock (Germany)
- Swiss Workshop on “Materials with Novel Electronic Properties”, 29 June - 1 July 2011, Les Diablerets (Switzerland)
- DAMOP Meeting, 25-29 May 2010, Houston (Texas-USA)

Talks given at Review Meetings:

- DARPA Review meeting, Optical Lattice Emulator project, 20-24 June 2011, Vail (Colorado-USA)
- DARPA Review meeting, Optical Lattice Emulator project, 23-25 May 2010 Houston (Texas-USA)
- QSIT Meeting, 27-29 January 2010, Arosa (Switzerland).
- Joint Trento-Innsbruck Meeting, 30 November 2007, Innsbruck (Austria)

Computer/Programming skills:

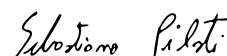
- Programming in C/C++, Fortran90, Python, Bash scripts.
- Parallel Programming (OPENMP).
- Use of modern libraries of Linear Algebra Computations (PLASMA, Lapack).
- Microsoft Office (Word, Excel, PowerPoint), OpenOffice, Xmgrace, Gnuplot
- Versioning and revision control systems (Github, SVN, Vistrails).

Language skills: fluent in Italian, English and Spanish, basic knowledge of German (level A2.1 of CEFR).

Ai sensi del D.lgs 196/2003 (tutela delle persone e di altri soggetti rispetto al trattamento dei dati personali) autorizzo al trattamento dei dati contenuti nel presente curriculum per lo svolgimento dell'attività di selezione della candidatura.

15 May 2017

Sebastiano Pilati



BIBLIOGRAPHIC DATA AND COMPLETE PUBLICATION LIST

Published Articles: 23

- 1 in Nature Physics
- 8 in Physical Review Letters (6 as first author, 1 as last author)
- 7 in Physical Review A (4 as first author, 2 as last author, 2 are Rapid Communication, 1 is Editor Suggestion)
- 2 in New Journal of Physics (1 as first author)
- 2 in Physical Review B (as last author)
- 1 in Physical Review E (as last author)
- 1 in Journal of Statistical Mechanics: Theory and Experiment
- 1 in Condensed Matter Theories

Citations according to ISI - Web of Science (Thomson Reuters)

- Sum of the Times Cited: 477
- Sum of the Times Cited without Self-Citations: 442
- h-index (Web of Science): 11

Citations according to Google Scholar: 674 h-index: 13

Articles published in peer-reviewed journals:

23. G. Mossi, T. Parolini, S. Pilati, A. Scardicchio, "On the quantum spin glass transition on the Bethe lattice", Journal of Statistical Mechanics: Theory and Experiment, 2017 (1), 013102
22. S. Pilati, V.K. Varma, "Localization of interacting Fermi gases in quasiperiodic potentials" Physical Review A **95**, 013613 (2017)
21. V. K. Varma, S. Pilati, V. E. Kravtsov, "Conduction in quasi-periodic and quasi-random lattices: Fibonacci, Riemann, and Anderson models" Physical Review B **94**, 214204 (2016)
20. S. Pilati, E. Fratini, "Ferromagnetism in a repulsive atomic Fermi gas with correlated disorder" Physical Review A **93**, 051604(R) (2016)
19. E. Fratini, S. Pilati, "Anderson localization in optical lattices with correlated disorder" Physical Review A **92**, 063621 (2015)
18. E. M. Inack, S. Pilati, "Simulated quantum annealing of double-well and multi-well potentials" Physical Review E **92**, 053304 (2015)
17. V. K. Varma, S. Pilati, "Kohn's localization in disordered fermionic systems with and without interactions" Physical Review B **92**, 134207 (2015)
16. E. Fratini, S. Pilati, "Anderson localization of matter waves in quantum-chaos theory" Physical Review A **91**, 061601(R) (2015) **Editors' Suggestion**
15. E. Fratini, S. Pilati, "Zero-temperature equation of state and phase diagram of repulsive fermionic mixtures" Physical Review A **90**, 023605 (2014)
14. T. T. Nguyen, A. J. Herrmann, M. Troyer, S. Pilati, "Critical Temperature of Interacting Bose Gases in Periodic Potentials" Physical Review Letters **112**, 170402 (2014)
13. S. Pilati, I. Zintchenko, M. Troyer, "Ferromagnetism of a Repulsive Atomic Fermi gas in an Optical Lattice: a Quantum Monte Carlo study" Physical Review Letters **112**, 015301 (2014)
12. P. N. Ma, S. Pilati, M. Troyer, X. Dai, "Density functional theory for atomic Fermi gases" Nature Physics **8**, 601-605 (2012)
11. S. Pilati, M. Troyer, "Bosonic superfluid-insulator transition in continuous space", Physical Review Letters **108**, 155301 (2012)
10. S. Nascimbène, N. Navon, S. Pilati, F. Chevy, S. Giorgini, A. Georges, C. Salomon, "A new Fermi liquid: the normal phase of a strongly interacting gas of cold atoms" Physical Review Letters **106**, 215303 (2011)
9. S. Pilati, G. Bertaina, S. Giorgini, M. Troyer, "Itinerant ferromagnetism of a repulsive atomic Fermi gas: a quantum Monte Carlo study"

Physical Review Letters **105**, 030405 (2010)

8. S. Pilati, S. Giorgini, M. Modugno, N. Prokofev, “*Dilute Bose gas with correlated disorder: a path integral Monte Carlo study*”
New Journal of Physics **12**, 073003 (2010)
7. B. Capogrosso-Sansone, S. Giorgini, S. Pilati, L. Pollet, N. V. Prokofev, B. V. Svistunov, and M. Troyer, “*Beliaev technique for a weakly interacting Bose gas*”
New Journal of Physics **12**, 043010 (2010)
6. S. Pilati, S. Giorgini, N. Prokofev, “*Superfluid Transition in a Bose Gas with Correlated Disorder*”
Physical Review Letters **102**, 150402 (2009)
5. S. Pilati, S. Giorgini, N. Prokofev, “*Critical Temperature of Interacting Bose Gases in Two and Three Dimensions*”
Physical Review Letters **100**, 140405 (2008)
4. S. Pilati, S. Giorgini, “*Phase separation in a polarized Fermi gas at zero temperature*”
Physical Review Letters **100**, 030401 (2008)
3. S. Pilati, K. Sakkos, J. Boronat, J. Casulleras and S. Giorgini, “*Equation of State of an interacting Bose gas: A path-integral Monte Carlo study*” Physical Review A **74**, 043621 (2006)
2. J. Boronat, G. E. Astrakharchik, J. Casulleras, S. Giorgini, S. Pilati, “*Quantum Monte Carlo in the Study of Dilute Bosonic and Fermionic Gases*”
CONDENSED MATTER THEORIES **20**, 395 (2006)
1. S. Pilati, J. Boronat, J. Casulleras and S. Giorgini, “*Quantum Monte Carlo simulation of a two-dimensional Bose gas*”
Physical Review A **71**, 023605 (2005)

15 May 2017

Sebastiano Pilati

