

Curriculum Vitae

Davide Rossini

updated on April 2018

General Information

Date of Birth: 14 July 1979
Place of birth: Como, Italy
Nationality: Italian
Marital Status: Married (10 July 2015)
Academic degrees: PhD in Physics (2007)
Master degree (“Laurea”) in Physics (2003)
Current Position: Senior Researcher (RTD B)
Present Institution: University of Pisa (UniPi),
Physics Department
Largo B. Pontecorvo 3, 56127 Pisa, Italy
E-mail: davide.rossini@unipi.it
Homepage: daviderossini.wordpress.com
Office tel. n. : +39-050-2214-930
Fax n. : +39-050-2214-887



Education: 24/09/2007 PhD with merits in Physics (70/70 cum laude)
Thesis: “*Quantum information processing and quantum spin systems*”
supervisor: Prof. Rosario Fazio
2004-2006 PhD student
Scuola Normale Superiore – SNS (Pisa, Italy)
09/07/2003 Degree with merits in Physics (110/110 cum laude)
Thesis: “*Stabilità ed entanglement eco nel calcolo quantistico*”
supervisors: Prof. Giulio Casati and Dr. Giuliano Benenti
1998-2003 Master in Physics
Università degli Studi dell'Insubria (Como, Italy)

Employments: 2017-2019 Senior Researcher @ UniPi (RTD B)
2013-2016 Junior Researcher @ SNS (RTD A)
2010-2013 Research fellowship
(EU project *SOLID* - financed through FP7-ICT-2009-4)
2007-2010 Postdoc @ International School for Advanced Studies – SISSA, Trieste
2007 Research fellow with Prof. R. Fazio @ SNS

Summary of Scientific Activity

- Co-author of more than 70 papers published in peer-reviewed international journals, including Nature Commun, Phys. Rev. Lett., X, A, B, E, New J. Phys., J. Stat. Mech., Europhys. Lett.
- Publication Record (data taken from *ISI Web of Science*)

Researcher-ID number	A-8156-2012
h-index	24
Total citations number	1825 [April 2018]
- Participation to several international conferences/workshops giving 21 invited talks
- Fund raising: PI of a “*FIRB – Futuro in Ricerca*” project, granted by the Italian Ministry of University and Research (MIUR); total budget: 860 k€. Grant FFABR 2017, from Italian MIUR. Budget: 3k€.
- Italian qualification to the role of “*Professore II fascia*” in theoretical condensed matter physics (Sec. 02/B2 - 2012) and in theoretical physics (Sec. 02/A2 – 2018); qualification to the role of “*Professore I fascia*” in theoretical condensed matter physics (Sec. 02/B2 - 2017).
- French qualification to the role of “*Maître de Conférences*” and of “*Professeur des Universités*” in Sec. 28 (Milieux denses et matériaux) and in Sec. 30 (Milieux dilués et optique) – February 2017
- One Book in preparation with: Giuliano Benenti, Giulio Casati (Como), Giuliano Strini (Milano). “*Principles of quantum Computation and Information – Second Edition*” (World Scientific Press). Estimated publication date: Jan. 2019

Grants and Awards

- 2017 FFABR (“*Finanziamento delle attività di base della ricerca*”). Granted by the Italian Ministry of Education, Universities and Research (MIUR). Budget: 3.000 €
- 2015 – 2017 PI of four “*Class C projects*” for the ISCRA Program at the Italian CINECA <http://www.hpc.cineca.it/services/iscra>
- The many-body physics of gauge invariant Bose-Hubbard ladders (50.000 hrs, Dec. 2017 – Sep. 2018)
Linked cluster expansions for quantum dissipative lattice models (50.000 hrs, Feb 2017 – Nov 2017)
Simulating quantum annealing protocols in open many-body systems (35.000 hrs, Feb 2016 – Dec 2016)
Signatures of many-body localization in the dynamics of bosons on disordered 1D systems (100.000 hrs, Apr 2015–Jan 2016)
- 2015 PI of a project sponsored by the “*Universities Space Research Association*” – NASA, USA <http://www.usra.edu/quantum/rfp/>
- Title: Quantum annealing in driven open many-body systems: simulating adiabatic computation on a real quantum computer
- Grant: 200 hours of effective computational time to be run on the D-Wave System at NASA, CA, USA
- 2013 – 2016 PI of a project FIRB 2012 “*Futuro in Ricerca*”. Grant by MIUR – <http://futuroinricerca.miur.it/>
- Title: Probing novel phases of matter with artificial quantum simulators: the interplay between disorder and correlations in equilibrium and out-of-equilibrium many-body quantum lattices.
- Total budget: 860.000 € over three partners (SNS, LENS Florence, University of Padova)
- 2011 Study award “*Gilberto Bernardini*” for the best PhD thesis in the science class of Scuola Normale Superiore, during the period 2007-2009

Research Interests

Strongly correlated low dimensional quantum systems

- quantum phase transitions, quantum magnetism
- quantum quenches & thermalization in closed systems
- driven dissipative many-body open systems

Quantum information & Many-body physics

- entanglement and non-classical correlations
- decoherence, quantum baths, many-body environments
- chaos and ergodicity in quantum statistical mechanics

Numerical algorithms

- density matrix renormalization group (DMRG)
- matrix product states (MPS) and tensor networks
- methods for open quantum systems

Teaching Activity

2017/18	Physics (Assistant) Undergraduates in Earth Science @ UniPi – 20 hours
2016/17, 2017/18	Physics (Teacher) Undergraduates in Computer Science @ UniPi – 48 hours
2017	Many-body physics in open quantum systems (Teacher) CUI Graduate days @ University of Hamburg – 9 hours (March 2017)
2015/16, 2016/17	Statistical mechanics (Teacher) Undergraduates in Physics @ SNS – 40 hours
2014/15, 2015/16, 2016/17	Quantum information II (Co-Teacher) PhD students in Physics @ SNS – 20 hours
2013-14	Statistical mechanics and quantum information (Teacher) PhD students in Physics @ SNS – 20 hours
2013-14, 2014-15	Statistical mechanics (Assistant Teacher) Undergraduates in Physics @ SNS – 16 hours exercises
2014	Complementi di meccanica quantistica (Co-Teacher) Undergraduates in Physics @ SSC Catania, Italy – 9 hours (July 2014)
2013	DMRG & tensor networks for the many-body quantum problem (Teacher) PhD students in Physics @ SISSA, Italy – 6 hours, (March 2013)

Tutoring activity

Supervisor of the following **Bachelor students**:

Alessandro Candido (UniPi 2017, supervised).

Title: “*Termalizzazione in sistemi quantistici: il principio canonico generale*”.

Federico Belliardo (UniPi 2017, supervised).

Title: “*Anderson localization in optical lattices*”.

(Co)-supervisor of the following **Master students**:

Salvatore Tirone (UniPi 2018-now, supervised).

Topic: *simulation of quantum Hall-like effect with ultracold atoms in synthetic dimensions*.

Francesca Collu (UniPi 2017-now, supervised).

Topic: *open quantum systems, corner-space renormalization group algorithms*

Andrea Politano (UniPi 2017–now, supervised).

Topic: *multipartite entanglement properties in many-body localized systems*.

Michele Pini (University of Florence 2016, supervised, final mark: 110/110 cum laude).

Title: “*Signatures of magnetic crystals in a three-leg ladder system with synthetic gauge fields*”.

Glen Mbeng (SNS 2015, co-supervised, final mark: 110/110 cum laude).

Title: “*Localizzazione a molti corpi in una catena di bosoni fortemente interagenti*”.

Alessandro David (UniPi 2014/2015, co-supervised, final mark: 110/110 cum laude).

Title: “*A ground state search algorithm for strongly correlated 1D quantum systems*”.

Andrea Sonnellini (UniPi 2013/2014, co-supervised, final mark: 110/110).

Title: “*Phase diagram of a fully-frustrated Bose-Hubbard diamond chain*”.

(Co)-supervisor of the following **PhD students**:

Davide Nigro (UniPi 2017–now, co-supervised).

Topics: *open quantum many-body systems, dissipative phase transitions*.

Maximilian Keck (SNS 2016–now, co-supervised).

Topics: *open quantum many-body systems, quantum annealing, tensor networks*.

Alberto Biella (SNS 2013/2016, co-supervised, final judgment: promoted cum laude).

Title: “*Many-body physics in open quantum system*”.

Sebastiano Peotta (SNS 2011/2013, co-supervised, final mark: 70/70 cum laude).

Title: “*Nonequilibrium dynamics of strongly correlated one-dimensional ultracold quantum gases*”.

Elena Canovi (SISSA 2007/2010, co-supervised, final judgment: promoted cum laude).

Title: “*Quench dynamics of many-body systems*”.

(Co)-supervisor of the following **Post-docs**:

Fernando Iemini (SNS 2015/2016, co-supervised – now at ICTP Trieste, Italy).

Topics: *quantum spin chains, Majorana fermions*.

Leonardo Mazza (SNS 2014/2015, co-supervised – now at ENS Paris, France).

Topics: *ultracold quantum gases, quantum magnetism*.

Jiasen Jin (SNS 2012/2014, co-supervised – now at Dalian University of Technology, China).

Topics: *dissipative quantum many-body systems, coupled QED cavities*.

Miscellanea

- Referee of several international scientific publishers, including: *American Association for the Advancement of Science* (Science), *American Physical Society* (Phys. Rev. A, B, E, X, Letters), *Nature Publishing Group* (Nature Commun., Sci. Rep.), *Institute of Physics* (EPL, New J. Phys., J. Stat. Mech., J. Phys. A, B, J. Phys. Cond. Matter), *EDP Sciences* (Eur. Phys. J. B, D), and *World Scientific Press* (Int. J. Quant. Inf.).
- Referee of the following Master Theses:
 - Gabriele Iallorezi “*Trasporto quantistico fuori equilibrio a frequenza finita*”
(supervised by Mihail Mintchev) @ UniPi, 11 December 2017
 - Claudio Bonanno “*Investigation of the topological properties of the CP^{N-1} model using Monte Carlo simulations*”
(supervised by Massimo D’Elia) @ UniPi, 18 October 2017
 - Dario Gatto “*Degradation of entanglement in Markovian Noise*”
(supervised by Vittorio Giovannetti and Antonella De Pasquale) @ UniPi, 22 September 2017
 - Antonio Tripodo “*Critical behavior of the three-dimensional antiferromagnetic RP^{N-1} model*”
(supervised by Ettore Vicari) @ Unipi, 21 September 2017
- Referee of the following PhD Theses:
 - Giacomo Valtolina “*Superfluid and spin dynamics of strongly interacting atomic Fermi gases*”
(supervised by Rosario Fazio and Massimo Inguscio) @ SNS, Pisa, 18 July 2016
 - Angelo Russomanno “*Periodic driving of a coherent quantum manybody system and relaxation to the Floquet diagonal ensemble*”
(supervised by Giuseppe Santoro) @ SISSA, Trieste, 31 November 2014
 - Giuseppe Menegoz “*Prethermalization after a sudden quench in a weakly interacting Bose system*”
(supervised by Alessandro Silva) @ SISSA, Trieste, 30 November 2014
 - Simone Ziraldo “*Thermalization and relaxation after a quantum quench in disordered Hamiltonians*”
(supervised by Giuseppe Santoro) @ SISSA, Trieste, 18 November 2013
 - Sebastiano Peotta “*Nonequilibrium dynamics of strongly correlated one-dimensional ultracold quantum gases*”
(supervised by Rosario Fazio and Marco Polini) @ SNS, Pisa, 5 June 2013
- Member of an “*IBM Linux on Power Innovation Grant*” for the development of an open-source DMRG code written in Fortran language – qti.sns.it/dmrg/phome.html
- Member of the committee for 1st year entrance examination at Scuola Normale Superiore (2016).

Selected Conferences and Workshops

Memorial workshop in honor of Frank Hekking

Les Houches, France, 28 – 30 January 2018

Invited talk: “*Dissipation and adiabatic quantum computation*”

Numerical Methods for Quantum Optics

Garching – Munich, Germany, 25 – 26 January 2018

Invited talk: “*Dissipation in adiabatic quantum computers*”

Quantum gases, Fundamental interactions and Cosmology" (QFC 2017)

Pisa, Italy, 25 – 27 October 2017

Invited talk: “*Chiral edge modes and crystalline phases in atomic synthetic ladders*”

Italian Quantum Information Science Conference (IQIS 2017)

Florence, Italy, 12 – 15 September 2017

Invited talk: “*Dissipation in adiabatic quantum computers: lessons from an exactly solvable model*”

Workshop “From static to dynamical gauge fields with ultracold atoms”

Florence, Italy, 6 June 2017

Contributed talk: “Chiral edge modes and Laughlin-like states in atomic synthetic ladders”

Conference on “Quantum fluids of light and matter”

Cargèse, Corsica, 8 – 12 May 2017

Contributed talk: “Linked cluster expansions for open quantum systems”

Workshop on “Numerical Methods for Quantum Optics”

Madrid, Spain, 26 – 27 January 2017

Invited talk: “Linked cluster expansions for dissipative quantum systems”

Eight International Workshop “Quantum Gases and Quantum Coherence” (BEC 2016)

Salerno, Italy, 31 August – 3 September 2016

Invited talk: “Localized Majorana-like modes in a number conserving setting”

School and Workshop on “Quantum Simulations and Many-Body Physics with Light”

Chania (Crete), Greece, 4 – 11 June 2016

Contributed talk: “Cluster mean-field approach to the steady-state phase diagram of dissipative spin systems”

Workshop on “Numerical Methods for Open Quantum Many-body Systems”

Vienna, Austria, 27 – 28 January 2016

Invited talk: “Cluster mean-field expansions for driven-dissipative systems”

Program “Many-body physics with light” (DENSELIGHT15)

KITP, Santa Barbara, USA, 29 October 2015

Invited Talk: “Numerical approaches to dissipative quantum phase transitions”

Italian National Conference on Condensed Matter Physics (FISMAT 2015)

Palermo, Italy, 30 September – 1 October 2015

Contributed talk: “Localized Majorana-like modes in a number conserving setting”

NITheP Research Workshop on “Nonequilibrium physics of driven-dissipative many-body systems”

Palm Dune Beach Lodge, South Africa, 21 – 25 September 2015

Invited talk: “Many-body simulations of open quantum systems”

BEC 2015 – Frontiers in Quantum Gases

Sant Feliu de Guixols, Spain, 5 – 11 September 2015

Poster: “Optimal persistent currents for interacting bosons on a ring with a gauge field”

Atomtronics

Benasque, Spain, 4 – 9 May 2015

Contributed Talk: “Coherent superposition of current flows in an Atomtronic Quantum Interference Device”

17th Symposium on “Topological Quantum Information”

Garching – Munich, Germany, 16 – 17 April 2015

Contributed Talk: “Topological superconductors in number-conserving atomic quantum wires”

International Winter School and Workshop on “Strongly correlated fluids of light and matter”

Trento, Italy, 14 – 22 January 2015

Invited talk: “Many-body simulations of open systems”

Condensed Matter in Paris (CMD25 – JMC14)

Paris, France, 25 – 29 August 2014

Invited talk: “Optimal persistent currents for interacting bosons stirred on a ring”

International Conference on Problems of Strongly Correlated and Interacting Systems (RQC14)

St. Petersburg, Russia, 28 – 31 May 2014

Contributed Talk: “Optimal persistent currents for interacting bosons stirred on a ring”

University of Trento, BEC Center – Joint meeting Trento-Pisa

Trento, Italy, 5 March 2014

Invited talk: “Magnetic properties of strongly interacting spin-orbit coupled bosons on a one-dimensional lattice”

Quantum Simulations

Benasque, Spain, 29 September – 4 October 2013

Contributed talk: “*Photon solid phases in driven arrays of nonlinearly coupled cavities*”

XCIX Congresso Nazionale della Società Italiana di Fisica (SIF 2013)

Trieste, Italy, 23 – 27 September 2013

Invited talk: “*Superfluidity after a quench in a many-body quantum system*”

Optics of Excitons in Confined Systems (OECS13)

Roma, Italy, 9 – 13 September 2013

Invited talk: “*Strongly correlated polaritons in coupled cavities*”

Low-D Quantum Condensed Matter 2013, Amsterdam Summer Workshop

Amsterdam, The Netherlands, 8 – 12 July 2013

Invited talk: “*Quantum quench dynamics of non-integrable spin-1 chains*”

Quantum Information Processing and Communication, International Conference (QIPC 2013)

Florence, Italy, 30 June - 5 July 2013

Contributed talk: “*Dynamics of strongly correlated ultracold quantum systems*”

New trends in complex quantum system dynamics

Cartagena, Spain, 8 – 12 April 2013

Contributed Talk: “*Quantum dynamics of strongly correlated one-dimensional systems*”

Quantum Dynamics in Far from Equilibrium Thermally Isolated Systems

KITP, Santa Barbara, USA, 10 October 2012 [invitation from 8 Oct. to 22 Oct.]

Invited Talk: “*Interacting bosons in 1D lattices: statics and dynamics of topological insulating phases*”

5th Italian Quantum Information Science Conference

Padova, Italy, 26 – 28 September 2012

Contributed Talk: “*Improved variational technique for tensor network structures*”

Statistical Physics and Low Dimensional Systems

Pont-à-Mousson, France, 29 May – 1 June 2012

Invited Talk: “*Interacting bosons in 1D lattices: statics and dynamics of topological insulating phases*”

Networking tensor networks: many-body systems and simulations

Benasque, Spain, 6 – 19 May 2012

Contributed Talk: “*Improved variational technique for tensor network structures*”

Many-Body Quantum Dynamics in Closed Systems

Barcelona, Spain, 7 – 9 September 2011

Invited Talk: “*Thermalization after a quench in a many-body closed quantum system*”

Problemi Attuali di Fisica Teorica

Vietri Sul Mare, Italy, 15 – 20 April 2011

Invited Talk: “*Ground state factorization and correlations in a quantum many-body system with broken symmetry*”

Quantum Simulations

Benasque, Spain, 28 February – 5 March 2011

Invited Talk: “*Superfluid and supersolid phases in 1D Matrix Product States with periodic boundary conditions*”

Heat Control and Thermoelectric Efficiency

Erice, Italy, 23 – 28 October 2010

Invited Talk: “*Thermalization and ergodicity in many-body open quantum systems*”

2nd Italian Quantum Information Science Conference

Pisa, Italy, 5 – 8 November 2009

Contributed Talk: “*Thermalization and ergodicity in many-body open quantum systems*”

1st Italian Quantum Information Science Conference

Camerino, Italy, 24 – 29 October 2008

Contributed Talk: “*Spin chain model for correlated quantum channels*”

Visits and Seminars

International Centre for Theoretical Physics (ICTP)

Trieste, Italy, 3 – 7 July 2017

Invited lectures: “*Quantum many-body systems using tensor network: An introduction*” (3 hrs).

Institute de Physique de Nice – Université Nice Sophia Antipolis

Valbonne (Nice), France, 29 – 30 June 2017

Seminar: “*Chiral edge modes and Laughlin-like states in atomic synthetic ladders*”

The Galileo Galilei Institute for Theoretical Physics (GGI)

Arcetri (Florence), Italy, 29 May – 16 June 2017

Workshop: “*From static to dynamical gauge fields with ultracold atoms*”.

CUI Graduate Days (University of Hamburg, Centre for Ultrafast Imaging)

Hamburg, Germany, 12 – 16 March 2017

Invited lectures: “*Many-body physics in open quantum systems*” (9 hrs).

École Normale Supérieure, Département de Physique

Paris, France, 7 April 2016

Seminar: “*Cluster mean-field approach to the steady-state phase diagram of dissipative spin systems*”

University of Innsbruck, Institute for Theoretical Physics

Innsbruck, Austria, 16 March 2016

Seminar: “*Cluster mean-field approach to the steady-state phase diagram of dissipative spin systems*”

University of Bari, Mathematics Department

Bari, Italy, 21 December 2015

Seminar: “*Localized Majorana-like modes in a number-conserving setting*”

The Kavli Institute for Theoretical Physics (KITP)

Santa Barbara, USA (period of visit: 3 – 31 October 2015)

Program on: “*Many-body physics with light*”

Institute of Physics, Johannes Gutenberg-Universität Mainz

Mainz, Germany, 30 June – 2 July 2015

Seminar: “*Topological superconductors in number-conserving atomic quantum wires*”

University of Oxford, Department of Physics – Clarendon Laboratory

Oxford, UK, 22 – 26 June 2015

Scientific collaboration with the group of Prof. V. Vedral

Laboratoire de Physique et Modélisation des Milieux Condensés, CNRS Grenoble

Grenoble, France, 19 November 2014

Seminar: “*Quantum dynamics of strongly correlated low dimensional systems*”

University of Pisa, Physics Department

Pisa, Italy, 29 October 2013

Seminar: “*Quantum quenches, linear response and superfluidity out of equilibrium*”

Nottingham University, School of Physics and Astronomy

Nottingham, UK, 12 June 2013

Seminar: “*Coherent quantum dynamics of strongly correlated one-dimensional systems*”

University of Pisa, Department of Mathematics

Pisa, Italy, 27 May 2013

Seminar: “*Density Matrix Renormalization Group for the 1D quantum many-body problem*”

Utrecht University, Institute for theoretical Physics

Utrecht, The Netherlands, 24 January 2013

Seminar: “*Strongly correlated many-body quantum systems in low dimensions*”

Queen's University Belfast, CTAMOP

Belfast, UK, 14 November 2012

Seminar: *“Interacting bosons in 1D lattices: statics and dynamics of topological insulating phases”*

The Kavli Institute for Theoretical Physics (KITP)

Santa Barbara, USA (period of visit: 7 – 22 October 2012) – Program on “quantum dynamics in far-from-equilibrium thermally isolated systems”

Seminar: *“Interacting bosons in 1D lattices: statics and dynamics of topological insulating phases”*

Stuttgart University, Institut für Theoretische Physics III

Stuttgart, Germany, 4 June 2012

Seminar: *“Interacting bosons in 1D lattices: statics and dynamics of topological insulating phases”*

University of the Basque Country

Bilbao, Spain (period of visit: 29 January – 10 February 2012)

Scientific collaboration with the group of Prof. E. Solano

Centre for Quantum Technologies (CQT)

National University of Singapore, Singapore (period of visit: 1 – 21 December 2010)

Seminar (15 Dec): *“Thermalization after a quench in many-body closed quantum systems”*

Centre for Quantum Technologies (CQT)

National University of Singapore, Singapore (period of visit: 3 – 20 December 2009)

Seminar (15 Dec): *“Many-body effects in strongly correlated quantum systems”*

Scuola Normale Superiore

Pisa, Italy, 19 November 2008

Seminar: *“Effective thermal dynamics following a quantum quench in a spin chain”*

List of Publications

Preprints on arXiv.org

- a) Energy transport in an integrable parafermionic chain via generalized hydrodynamics
L. Mazza, J. Viti, M. Carrega, D. Rossini, and A. De Luca
arXiv:1804.04476
- b) On the optimal working point in dissipative quantum annealing
L. Arceci, S. Barbarino, D. Rossini, and G. E. Santoro
arXiv:1804.04251
- c) Dynamic finite-size scaling after a quench at quantum transitions
A. Pelissetto, D. Rossini, and E. Vicari
arXiv:1804.03102

Regular Articles

- 1) *Quantum correlations and limit cycles in the driven-dissipative Heisenberg lattice*
E. T. Owen, J. Jin, D. Rossini, R. Fazio, and M. J. Hartmann
New J. Phys. (2018, to appear) – arXiv:1711.11309
- 2) *Out-of-equilibrium dynamics of repulsive Fermi gases in quasi-periodic potentials: a Density Functional Theory study*
F. Ancilotto, D. Rossini, and S. Pilati
Phys. Rev. B **97**, 155107 (2018)

- 3) *Off-equilibrium dynamics driven by localized time-dependent perturbations at quantum phase transitions*
A. Pelissetto, D. Rossini, and E. Vicari
Phys. Rev. B **97**, 094414 (2018)
- 4) *Quantum phases of spinful Fermi gases in optical cavities*
E. Colella, R. Citro, M. Barsanti, D. Rossini, and M. L. Chiofalo
Phys. Rev. B **97**, 134502 (2018)
- 5) *From localization to anomalous diffusion in the dynamics of coupled kicked rotors*
S. Notarnicola, F. Iemini, D. Rossini, R. Fazio, A. Silva, and A. Russomanno
Phys. Rev. E **97**, 022202 (2018)
- 6) *Linked cluster expansions for open quantum systems on a lattice*
A. Biella, J. Jin, O. Viyuela, C. Ciuti, R. Fazio, and D. Rossini
Phys. Rev. B **97**, 035103 (2018)
- 7) *Resilience of hidden order to symmetry-preserving disorder*
M. Calvanese Strinati, D. Rossini, R. Fazio, and A. Russomanno
Phys. Rev. B **96**, 214206 (2017)
- 8) *Dissipation in adiabatic quantum computers: Lessons from an exactly solvable model*
M. Keck, S. Montangero, G. E. Santoro, R. Fazio, and D. Rossini
New J. Phys. **19**, 113029 (2017)
- 9) *Stabilizing strongly correlated photon fluids with a non-Markovian reservoir*
J. Lebreuilly, A. Biella, F. Storme, D. Rossini, R. Fazio, C. Ciuti, and I. Carusotto
Phys. Rev. A **96**, 033828 (2017)
- 10) *Phase diagram of incoherently-driven strongly correlated photonic lattices*
A. Biella, F. Storme, J. Lebreuilly, D. Rossini, R. Fazio, I. Carusotto, and C. Ciuti
Phys. Rev. A **96**, 023839 (2017)
- 11) *Topological fractional pumping with alkaline-earth(-like) ultracold atoms*
L. Taddia, E. Cornfeld, D. Rossini, L. Mazza, E. Sela, and R. Fazio
Phys. Rev. Lett. **118**, 230402 (2017)
- 12) *Laughlin-like states in bosonic and fermionic atomic synthetic ladders*
M. Calvanese Strinati, E. Cornfeld, D. Rossini, S. Barbarino, M. Dalmonte, R. Fazio, E. Sela, and L. Mazza
Phys. Rev. X **7**, 021033 (2017)
- 13) *Signatures of many-body localisation in the dynamics of two-sites entanglement*
F. Iemini, A. Russomanno, D. Rossini, A. Scardicchio, and R. Fazio
Phys. Rev. B **94**, 214206 (2016)
- 14) *Local quantum thermal susceptibility*
A. De Pasquale, D. Rossini, R. Fazio, and V. Giovannetti
Nature Commun. **7**, 12782 (2016)
- 15) *Cluster mean-field approach to the steady-state phase diagram of dissipative spin systems*
J. Jin, A. Biella, O. Viyuela, L. Mazza, J. Keeling, R. Fazio, and D. Rossini
Phys. Rev. X **6**, 031011 (2016)
- 16) *Destruction of string order after a quantum quench*
M. Calvanese Strinati, L. Mazza, M. Endres, D. Rossini, and R. Fazio
Phys. Rev. B **94**, 024302 (2016)
- 17) *Energy transport between two integrable spin chains*
A. Biella, A. De Luca, J. Viti, D. Rossini, L. Mazza, and R. Fazio
Phys. Rev. B **93**, 205121 (2016)

- 18) *Synthetic gauge fields in synthetic dimensions: Interactions and chiral edge modes*
S. Barbarino, L. Taddia, D. Rossini, L. Mazza, and R. Fazio
New J. Phys. **18**, 035010 (2016)
- 19) *Dissipative topological superconductors in number-conserving systems*
F. Iemini, D. Rossini, R. Fazio, S. Diehl, and L. Mazza
Phys. Rev. B **93**, 115113 (2016)
- 20) *Localized Majorana-like modes in a number conserving setting: An exactly solvable model*
F. Iemini, L. Mazza, D. Rossini, R. Fazio, and S. Diehl
Phys. Rev. Lett. **115**, 156402 (2015)
- 21) *Quasiadiabatic dynamics of ultracold bosonic atoms in a one-dimensional optical superlattice*
A. Dhar, D. Rossini, and B. P. Das
Phys. Rev. A **92**, 033610 (2015)
- 22) *Magnetic crystals and helical liquids in alkaline-earth fermionic gases*
S. Barbarino, L. Taddia, D. Rossini, L. Mazza, and R. Fazio
Nature Commun. **6**, 8134 (2015)
- 23) *Photon transport in a dissipative chain of nonlinear cavities*
A. Biella, L. Mazza, I. Carusotto, D. Rossini, and R. Fazio
Phys. Rev. A **91**, 053815 (2015)
- 24) *Coherent superposition of current flows in an atomtronics quantum interference device*
D. Aghamalyan, M. Cominotti, M. Rizzi, D. Rossini, F. Hekking, A. Minguzzi, L.C. Kwek, and L. Amico
New J. Phys. **17**, 045023 (2015)
- 25) *Phase diagram of a QED-cavity array coupled via a N-type level scheme*
J. Jin, R. Fazio, and D. Rossini
EPJ Quantum Technology **2**, 5 (2015)
- 26) *Detecting two-site spin-entanglement in many-body systems with local particle-number fluctuations*
L. Mazza, D. Rossini, R. Fazio, and M. Endres
New J. Phys. **17**, 013015 (2015)
- 27) *Energy transport in Heisenberg chains beyond the Luttinger liquid paradigm*
A. De Luca, J. Viti, L. Mazza, and D. Rossini
Phys. Rev. B **90**, 161101 (2014)
- 28) *The XYZ chain with Dzyaloshinsky-Moriya interactions: from spin-orbit-coupled lattice bosons to interacting Kitaev chains*
S. Peotta, L. Mazza, E. Vicari, M. Polini, R. Fazio, and D. Rossini
J. Stat. Mech. (2014) P09005
- 29) *Steady-state phase diagram of a driven QED-cavity array with cross-Kerr nonlinearities*
J. Jin, D. Rossini, M. Leib, M.J. Hartmann, and R. Fazio
Phys. Rev. A **90**, 023827 (2014)
- 30) *Quantum quenches, linear response and superfluidity out of equilibrium*
D. Rossini, R. Fazio, V. Giovannetti, and A. Silva
Europhys. Lett. **107**, 30002 (2014)
- 31) *Out-of-equilibrium dynamics and thermalization of string order*
L. Mazza, D. Rossini, M. Endres, and R. Fazio
Phys. Rev. B **90**, 020301(R) (2014)
- 32) *Optimal persistent currents for interacting bosons on a ring with a gauge field*
M. Cominotti, D. Rossini, M. Rizzi, F. Hekking, and A. Minguzzi
Phys. Rev. Lett. **113**, 025301 (2014)

- 33) *Photon transfer in ultrastrongly coupled three-cavity arrays*
S. Felicetti, G. Romero, D. Rossini, R. Fazio, and E. Solano
Phys. Rev. A **89**, 013853 (2014)
- 34) *Quantum parameter estimation affected by unitary disturbance*
A. De Pasquale, D. Rossini, P. Facchi, and V. Giovannetti
Phys. Rev. A **88**, 052117 (2013)
- 35) *Photon solid phases in driven arrays of nonlinearly coupled cavities*
J. Jin, D. Rossini, R. Fazio, M. Leib, and M.J. Hartmann
Phys. Rev. Lett. **110**, 163605 (2013)
- 36) *Topological pumping in the one-dimensional Bose-Hubbard model*
D. Rossini, M. Gibertini, V. Giovannetti, and R. Fazio
Phys. Rev. B **87**, 085131 (2013)
- 37) *XXZ spin-1/2 representation of finite-U Bose-Hubbard chain at half-integer filling*
D. Giuliano, D. Rossini, P. Sodano, and A. Trombettoni
Phys. Rev. B **87**, 035104 (2013)
- 38) *Quantum breathing of an impurity in a one-dimensional bath of interacting bosons*
S. Peotta, D. Rossini, M. Polini, F. Minardi, and R. Fazio
Phys. Rev. Lett. **110**, 015302 (2013)
- 39) *Optimal correlations in many-body quantum systems*
L. Amico, D. Rossini, A. Hamma, and V. Korepin
Phys. Rev. Lett. **108**, 240503 (2012)
- 40) *Short-time spin dynamics in strongly correlated few-fermion systems*
S. Peotta, D. Rossini, P. Silvi, G. Vignale, R. Fazio, and M. Polini
Phys. Rev. Lett. **108**, 245302 (2012)
- 41) *Applicability of the generalized Gibbs ensemble after a quench in the quantum Ising chain*
T. Caneva, E. Canovi, D. Rossini, G.E. Santoro, and A. Silva
J. Stat. Mech. (2011) P07015
- 42) *Stiffness in 1D Matrix Product States with periodic boundary conditions*
D. Rossini, V. Giovannetti, and R. Fazio
J. Stat. Mech (2011) P05021
- 43) *Spin-supersolid phase in Heisenberg chains: a characterization via MPS with periodic boundary conditions*
D. Rossini, V. Giovannetti, and R. Fazio
Phys. Rev. B **83**, 140411(R) (2011)
- 44) *Phase diagram of hard-core bosons on a frustrated zig-zag ladder*
D. Rossini, V. Lante, A. Parola, and F. Becca
Phys. Rev. B **83**, 155106 (2011)
- 45) *Ground-state factorization and correlations with broken symmetry*
B. Tomasello, D. Rossini, A. Hamma, and L. Amico
Europhys. Lett. **96**, 27002 (2011)
- 46) *Quantum quenches, thermalization and many-body localization*
E. Canovi, D. Rossini, R. Fazio, G. Santoro, and A. Silva
Phys. Rev. B **83**, 094431 (2011)
- 47) *Long time dynamics following a quench in an integrable quantum spin chain: local versus non-local operators and effective thermal behavior*
D. Rossini, S. Suzuki, G. Mussardo, G. Santoro, and A. Silva

- Phys. Rev. B **82**, 144302 (2010) (see also: arXiv:0910.4055 [cond-mat])
- 48) *Thermalization and ergodicity in 1D many-body open quantum systems*
M. Žnidarič, T. Prosen, G. Benenti, G. Casati, and D. Rossini
Phys. Rev. E **81**, 051135 (2010)
- 49) *Charge and spin transport in strongly correlated one-dimensional quantum systems driven far from equilibrium*
G. Benenti, G. Casati, T. Prosen, D. Rossini, and M. Žnidarič
Phys. Rev. B **80**, 035110 (2009)
- 50) *Adiabatic dynamics in a spin-1 chain with uniaxial single-spin anisotropy*
E. Canovi, D. Rossini, R. Fazio, and G. Santoro
J. Stat. Mech. (2009) P03038
- 51) *Effective thermal dynamics following a quantum quench in a spin chain*
D. Rossini, A. Silva, G. Mussardo, and G. Santoro
Phys. Rev. Lett. **102**, 127204 (2009)
- 52) *Negative differential conductivity in far-from-equilibrium quantum spin chains*
G. Benenti, G. Casati, T. Prosen, and D. Rossini
Europhys. Lett. **85**, 37001 (2009)
- 53) *Photon and polariton fluctuations in arrays of QED-cavities*
D. Rossini, R. Fazio, and G. Santoro
Europhys. Lett. **83**, 47011 (2008)
- 54) *Spin chain model for correlated quantum channels*
D. Rossini, V. Giovannetti, and S. Montangero
New J. Phys. **10**, 115009 (2008)
- 55) *Bang-bang control of a qubit coupled to a quantum critical spin bath*
D. Rossini, P. Facchi, R. Fazio, G. Florio, D.A. Lidar, S. Pascazio, F. Plastina, and P. Zanardi
Phys. Rev. A **77**, 052112 (2008)
- 56) *Robust and efficient generator of almost maximal multipartite entanglement*
D. Rossini and G. Benenti
Phys. Rev. Lett. **100**, 060501 (2008)
- 57) *Mott-insulating and glassy phases of polaritons in 1D arrays of coupled cavities*
D. Rossini and R. Fazio
Phys. Rev. Lett. **99**, 186401 (2007)
- 58) *Decoherence induced by interacting quantum spin baths*
D. Rossini, T. Calarco, V. Giovannetti, S. Montangero, and R. Fazio
Phys. Rev. A **75**, 032333 (2007)
- 59) *Information transfer rates in spin quantum channels*
D. Rossini, V. Giovannetti, and R. Fazio
Int. J. Quant. Inf. **5**, 439 (2007)
- 60) *Conservative chaotic map as a model of quantum many-body environment*
D. Rossini, G. Benenti, and G. Casati
Phys. Rev. E **74**, 036209 (2006)
- 61) *Density matrix renormalization group for dummies*
G. De Chiara, M. Rizzi, D. Rossini, and S. Montangero
J. Comput. Theor. Nanosci. **5**, 1277 (2008) – [cond-mat/0603842]
- 62) *Phase diagram of spin-1 bosons on one-dimensional lattices*
M. Rizzi, D. Rossini, G. De Chiara, S. Montangero, and R. Fazio

- Phys. Rev. Lett. **95**, 240404 (2005)
- 63) *From perfect to fractal transmission in spin chains*
G. De Chiara, D. Rossini, S. Montangero, and R. Fazio
Phys. Rev. A **72**, 012323 (2005)
- 64) *Classical versus quantum errors in quantum computation of dynamical systems*
D. Rossini, G. Benenti, and G. Casati
Phys. Rev. E **70**, 56216 (2004)
- 65) *Entanglement echoes in quantum computation*
D. Rossini, G. Benenti, and G. Casati
Phys. Rev. A **69**, 052317 (2004)

Special Issues – Conferences Proceedings

- 1) *Strongly Correlated Polaritons in Nonlinear Cavity Arrays*
A. Tomadin, D. Rossini, R. Fazio
Book chapter in “Quantum Simulations with Photons and Polaritons: Merging Quantum Optics with Condensed Matter Physics” edited by D. G. Angelakis, Quantum Science and Technology Series, Springer 2017.
- 2) *Optimal scaling of persistent currents for interacting bosons on a ring*
M. Cominotti, M. Rizzi, D. Rossini, D. Aghamalyan, L. Amico, L.C. Kwek, F. Hekking, and A. Minguzzi
EPJ Special Topics **224**, 519 (2015) – [arXiv:1409.1835]
- 3) *Matrix product state representation for Slater determinants and configuration interaction states*
P. Silvi, D. Rossini, R. Fazio, G.E. Santoro, and V. Giovannetti
Int. J. Mod. Phys. B **27**, 1345029 (2013) – Focus issue on “Classical vs. quantum correlations in composite systems”
- 4) *Many-body localization and thermalization in the full probability distribution function of observables*
E. Canovi, D. Rossini, R. Fazio, G.E. Santoro, and A. Silva
New J. Phys. **14**, 095020 (2012) – Focus issue on “Out-of-equilibrium dynamics in strongly interacting one-dimensional systems”
- 5) *Phase diagram of the extended Bose Hubbard model*
D. Rossini and R. Fazio
New J. Phys. **14**, 065012 (2012) – Focus issue on “Bose Condensation Phenomena in Atomic and Solid State Physics”
- 6) *Quantum discord in a spin system with symmetry breaking*
B. Tomasello, D. Rossini, A. Hamma, and L. Amico
Int. J. Mod. Phys. B **26**, 1243002 (2012) – Contribution to the Festschrift volume “From Statistical Mechanics to Quantum Information Science” in honour of Vladimir Korepin
- 7) *Decoherence by engineered quantum baths*
D. Rossini, T. Calarco, V. Giovannetti, S. Montangero, and R. Fazio
J. Phys. A: Math. Theor. **40**, 8033 (2007) – Proceedings of the “School and Workshop on Theory and Technology in Quantum Information, Communication, Computation and Cryptography”, ICTP Trieste (Italy) 2006
- 8) *Dynamical chaos and decoherence*
G. Casati and D. Rossini
Progr. Theor. Phys. Suppl. **166**, 70 (2007) – Proceedings of the International Conference on “Quantum Mechanics and Chaos”, Osaka (Japan) 2006
- 9) *Anti-ferromagnetic spinor BECs in optical lattices*
D. Rossini, M. Rizzi, G. De Chiara, S. Montangero, and R. Fazio
J. Phys. B: At. Mol. Opt. Phys. **39**, S163 (2006) – Proceedings of the Third International Workshop “Theory of Quantum

10) *Implementation of quantum communication protocols in Josephson junction arrays*

A. Romito, G. De Chiara, D. Rossini, and S. Montangero

Int. J. Quant. Inf. **4**, 519 (2006) – Proceedings of the Workshop “Quantum Entanglement in Physical and Information Sciences”, SNS Pisa (Italy) 2004

Research Statement

My research activity is focused on the theoretical understanding of the role played by strong local correlations in low-dimensional many-body quantum systems, such as spin chains or fermionic/bosonic Hubbard-like models. These are believed to lie at the heart of many prominent aspects of quantum mechanics, including quantum phase transitions, high-temperature superconductivity, quantum magnetism, many-body localization, as well as topological order.

Despite the apparent simplicity of such systems, the lack of a dominant exactly solvable contribution limits the applicability of conventional perturbative methods, and restricts analytic studies to few cases. In high dimensionality mean-field approaches are often able to grasp the relevant features. In other circumstances approximated techniques as semiclassical theories or numerical approaches are an essential way out. I am an expert in numerical calculations for the many-body problem, including exact diagonalization, quantum trajectories and density matrix renormalization group (DMRG) approaches.

I am dealing with the study of different scenarios of the out-of-equilibrium quantum dynamics:

- i)* sudden quenches of closed systems, where abrupt variations of a Hamiltonian parameter induce a relaxation to a state which may locally resemble a canonical thermal ensemble (thermalization);
- ii)* quasi-adiabatic quenches where, no matter how slow the parameters are varied, the presence of criticality prevents adiabaticity from being applied, with the unavoidable formation of defects;
- iii)* non-equilibrium steady states in open dissipative systems, as those emerging in photonic nanostructures, where the coupling to the environment modifies the two previous scenarios.

Besides the academic interest, these investigations have been recently boosted by the spectacular experimental advances in the realization and manipulation of “*quantum simulators*”, even out of equilibrium. Among them I am very interested in ultracold atomic gases and in dissipative arrays of coupled QED cavities. Fruitful discussions with experimentalists working on cold atoms loaded in optical lattices (e.g., at LENS in Florence), enabled me to understand the emergence of peculiar behavior of quantum matter which is likely to be studied soon in the lab. I quote the stabilization of exotic magnetic crystals and of persistent currents in presence of synthetic gauge fields, the real-time dynamics of impurities and the propagation of their spin entanglement in highly controllable scenarios. In the many-body context of light-matter interaction, I analyzed the phase diagram of an array of coupled QED cavities, where inside each cavity an atom interacts with a radiation field. In the rotating-wave approximation, local interactions can be modeled by the Jaynes-Cummings model. Without dissipation, the system resembles the Bose-Hubbard physics for polaritonic dressed states. However the non-equilibrium conditions, under which photonic systems naturally operate, leads to intriguing scenarios with the appearance of new steady-state phases as photon crystals and even supersolid phases.

On a more fundamental level, I am exploring the many-body physics from a quantum information point of view. Spin chains are the prototype models, since the interplay between quantum correlations, phases of matter and entanglement develops in its fundamental aspects.

Some of my contributions focus on zero-temperature quantum phase transitions, signaled by sudden changes of the ground-state properties, as long as the Hamiltonian parameters are varied. A valuable

information is given by an information-theory analysis of quantum correlations (entanglement, quantum discord and related quantifiers), such as the strict relation between topological phases and entanglement spectrum properties. I also study basic quantum information processing protocols in spin networks, addressing the effects of both internal (unitary) and external (non-unitary) sources of noise. I am interested in the characterization of disordered many-body systems and on the appearance of a finite-temperature localization/delocalization transition. While this is framed in the context of the thermalization and ergodicity of closed systems, it is possible that such behavior could be revealed by entropic indicators, as well as quantum information-like fidelity approaches.

In the recent years I coordinated the numerical work in the “*Condensed matter and quantum information theory*” group in Pisa. I developed algorithms for the simulation of many-body quantum systems, based on the reformulation of t-DMRG methods in the tensor network formalism. This approach follows the recent advances within the quantum information community, which introduced the notion of matrix product states (MPS), as well as the multiscale entanglement renormalization ansatz (MERA), and the projected entangled pair states (PEPS).

I implemented a code, based on the MPS ansatz, for 1D lattices with periodic boundary conditions, which enables to study the system's response to a magnetic flux. I am working on the improvement of algorithms to study dissipative systems in the Lindblad formalism, while I would like to investigate the possibility to extend DMRG capabilities to address longer time scales and 2D systems, i.e., by integrating them with linked-cluster approaches.