Curriculum Vitae

Davide Rossini

updated on July 2016

General Information

Date of Birth:	14 July 1979
Place of birth:	Como, Italy
Nationality:	Italian
Academic degrees:	PhD in Physics (2007) Master degree ("Laurea") in Physics (2003)
Current Position:	Assistant Professor (temporary position)
Present Institution:	Scuola Normale Superiore (SNS) Piazza dei Cavalieri 7, I-56126 Pisa – Italy
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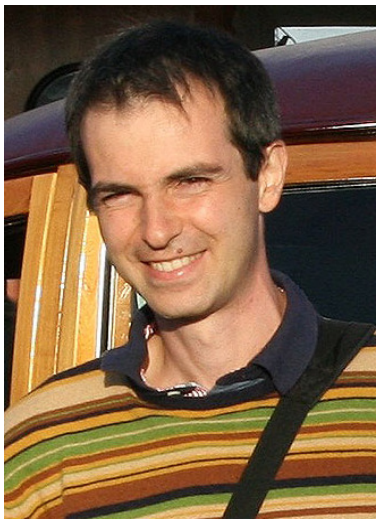

Education:	2007	PhD with merits in Physics (70/70 cum laude) Thesis: *"Quantum information processing and quantum spin systems"* supervisor: Prof. Rosario Fazio
	2004-2006	PhD student Scuola Normale Superiore (Pisa, Italy)
	2003	Degree with merits in Physics (110/110 cum laude) Thesis: "S*tabilità ed 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:	2013-2018	Assistant Professor @ SNS (non-tenured)
	2010-2013	Research fellowship (EU project *SOLID* - financed through FP7-ICT-2009-4)
	2007-2010	Post-doc @ International school for advanced studies (SISSA Trieste)
	2007	Research fellow with Prof. R. Fazio @ SNS

Summary of Scientific Activity

– Co-author of 60 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	18
Total citations number	1277 [July 2016]

– Participation to several international conferences/workshops giving 15 invited talks

– Fund raising: PI of a "*FIRB – Futuro in Ricerca"* project, granted by the Italian Ministry of University and Research (MIUR) from March 2013 to March 2016, 860 k€ (see Sec. "Grants & Awards" for details)

– Italian qualification for the associate professorship in Theoretical Condensed Matter Physics (2013)

– One Book in preparation with: Giuliano Benenti, Giulio Casati (Como), Giuliano Strini (Milano).
Title: "*Principles of quantum Computation and Information – Second Edition*"
Estimated working period: Jun. 2014 – Dec. 2016

– Supervision of the following students:

Michele Pini	2016 – now	Master student @ University of Florence
Maximilian Keck	2015 – now	PhD student @ SNS
Alberto Biella	2014 – now	PhD student @ SNS
Glen Mbeng	2015	Master student @ SNS
Alessandro David	2015	Master student @ University of Pisa
Fernando Iemini	2014 – 2015	PhD student @ Universidade Federal de Minas Gerais, Brasil
Andrea Sonnellini	2013 – 2014	Master student @ University of Pisa
Sebastiano Peotta	2011 – 2012	PhD student @ SNS
Elena Canovi	2007 – 2010	PhD student @ SISSA

– Referee of several international scientific publishers, including *American Association for the Advancement of Science* (Science), *American Physical Society* (Phys. Rev. *A*, *B*, *E*, Letters), *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.).

– Member of "*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

– Examiner of the following PhD Theses:

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

Research Interests

Strongly correlated low dimensional quantum systems
- Quantum phase transitions
- Quantum magnetism and exotic phases
- Quantum quenches, thermalization in closed systems
- Non-equilibrium physics of driven-dissipative many-body systems

Quantum information meets many-body physics
- Entanglement and correlations
- Decoherence, quantum baths, many-body environments
- Chaos and ergodicity in quantum statistical mechanics

Numerical algorithms
- Density matrix renormalization group
- Matrix product states and tensor networks
- Quantum trajectories and methods for open systems

Teaching Activity

A.Y. 2015/2016 Teacher: "*Statistical mechanics*" @ SNS – 60 hours (Nov 2014-Apr 2015)

Co-Teacher: "*Many-Body theory"* and *"Quantum Information II* "
Courses for PhD students @ SNS – 20 hours (Apr-Jun 2015)

A.Y. 2014/2015 Co-Teacher: "*Many-Body theory"* and *"Quantum Information II* "
Courses for PhD students @ SNS – 20 hours (May-Jun 2015)

Assistant teacher: "*Statistical mechanics*" @ SNS – 16 hours exercises (Nov-Dec 2014)

A.Y. 2013/2014 Teacher: "*Statistical mechanics and quantum information*"
Course for PhD students @ SNS – 20 hours (Apr-May 2014)

Assistant teacher: "*Statistical mechanics*" @ SNS – 12 hours exercises (Nov-Dec 2013)

Co-Teacher: "*Complementi di meccanica quantistica*"
Lectures for undergraduates @ SSC Catania, Italy – 9 hours (7-11 July 2014)

A.Y. 2012/2013 Teacher: *"DMRG and tensor-network methods for the many-body quantum problem"*
Lectures for PhD students @ SISSA, Italy – 6 hours (4-8 March 2013)

Collaborations

Present: Rosario Fazio (Trieste, Italy); Giuseppe Santoro, Alessandro Silva (Trieste, Italy); Frank Hekking, Anna Minguzzi (Grenoble, France); Sebastian Diehl (Cologne, Germany); Luigi Amico (Catania, Italy); Iacopo Carusotto (Trento, Italy); Jonathan Keeling (St.Andrews, UK); Leonardo Fallani, (Firenze, Italy)

Recent: Vittorio Giovannetti, Marco Polini (Pisa, Italy); Giulio Casati, Giuliano Benenti (Como, Italy); Giuseppe Mussardo, Andrea Trombettoni (Trieste, Italy); Enrique Solano (Bilbao, Spain); Iacopo Carusotto (Trento, Italy); Michael Hartmann (Edinburgh, United Kingdom); Manuel Endres (Caltech, USA); Tomaz Prosen, Marko Znidaric (Ljubliana, Slovenia).

Grants and Awards

2015 & 2016:	PI of two "Class C projects" for the ISCRA programme at the Italian CINECA http://www.hpc.cineca.it/services/iscra
Title (1):	Signatures of many-body localization in the dynamics of bosons on disordered 1D systems
Title (2):	Simulating quantum annealing protocols in open many-body systems
Duration:	9 months (Apr 2015–Jan 2016 & Feb 2016–Oct2016)
Grant:	100.000 + 35000 hours of computational time hosted at CINECA, Italy

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
Duration:	Approximately 1 year, starting from June 2015
Grant:	200 hours of effective computational time to be run on the D-Wave System at NASA, CA, USA

Quantum annealing is a promising tool to solve NP-complete problems, such as identifying the global minimum of a given function over a set of many local minima. Whether it represents an efficient strategy, has still to be understood. By a cross combination of advanced numerical methods for dissipative quantum systems and D-Wave quantum-computer simulations, we plan to give an answer to this question in a variety of realistic situations, which include finite-temperature and dissipative effects.

2013 – 2016:	PI of a "FIRB - Futuro in Ricerca" project, grant by "Italian Ministry of University & Research" 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.
Duration:	36 months, starting from Spring 2013
Granted money:	860.000 €
The team:	SNS, LENS laboratory in Florence, University of Padova

ArtiQuS targets the realization of artificial structures properly tailored to reproduce controlled strongly correlated quantum systems, in order to explore the role of disorder and the dynamics. By interfacing advanced theoretical methods with two different setups, ultracold atomic gases trapped in optical lattices and nanofabricated semiconductor quantum wells, we plan to study many-body lattice structures on which interacting quantum particles (bosons with cold atoms, or electrons in semiconductor structures) are able to tunnel from site to site.
The project addresses two frontier themes in many-body quantum physics: the role played by disorder and the out-of-equilibrium quenched dynamics of closed systems.
– Characterization of ground-state static properties of disordered Hubbard-like models. Phase-diagram modifications induced by finite temperatures. Stability of topological phases in presence of disorder.
– Thermalization following an abrupt quantum quench of an Hamiltonian parameter. Formation of defects after adiabatically crossing quantum phase transitions.

2011	Study award "Gilberto Bernardini" for the best PhD thesis in the science class of Scuola Normale Superiore, during the period 2007-2009

Selected Conferences and Workshops

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” (expected)*

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”
Technische Universität Wien @ Vienna, Austria, 27 – 28 January 2016
Invited talk: *“Cluster mean-field expansions for driven-dissipative systems”*

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”*

NIThePResearch 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)
Firenze, 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"*

Italian Quantum Information Science Conference
Pisa, Italy, 5 – 8 November 2009
Contributed Talk: *"Thermalization and ergodicity in many-body open quantum systems"*

Italian Quantum Information Science Conference
Camerino, Italy, 24 – 29 October 2008
Contributed Talk: *"Spin chain model for correlated quantum channels"*

Visits and Seminars

École Normale Supérieure, Département de Physique
Paris, 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, 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-bodty 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

1) *Local quantum thermal susceptibility*
A. De Pasquale, D. Rossini, R. Fazio, and V. Giovannetti
arXiv:1504.07787 (2015)

Regular Articles

1) *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 (2016, to appear) – arXiv:1602.06553

2) *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)

3) *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)

4) *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)

5) *Dissipative topological superconductors in number-conserving systems*
F. Iemini, D. Rossini, R. Fazio, S. Diehl, and L. Mazza
Phys. Rev. B **93**, 115113 (2016)

6) *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)

7) *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)

8) *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)

9) *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)

10) *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)

11) *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)

12) *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)

13) *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)

14) 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

15) *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)*

16) *Quantum quenches, linear response and superfluidity out of equilibrium*
D. Rossini, R. Fazio, V. Giovannetti, and A. Silva
Europhys. Lett. **107**, 30002 (2014)

17) *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)

18) *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)

19) *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)

20) *Quantum parameter estimation affected by unitary disturbance*
A. De Pasquale, D. Rossini, P. Facchi, and V. Giovannetti
Phys. Rev. A **88**, 052117 (2013)

21) *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)

22) *Topological pumping in the one-dimensional Bose-Hubbard model*
D. Rossini, M. Gibertini, V. Giovannetti, and R. Fazio
Phys. Rev. B **87**, 085131 (2013)

23) 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)*

24) *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)

25) *Optimal correlations in many-body quantum systems*
L. Amico, D. Rossini, A. Hamma, and V. Korepin
Phys. Rev. Lett. **108,** 240503 (2012)

26) *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)

27) *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

28) *Stiffness in 1D Matrix Product States with periodic boundary conditions*
D. Rossini, V. Giovannetti, and R. Fazio
J. Stat. Mech (2011) P05021

29) *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)

30) *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)

31) *Ground-state factorization and correlations with broken symmetry*
B. Tomasello, D. Rossini, A. Hamma, and L. Amico
Europhys. Lett. **96**, 27002 (2011)

32) *Quantum quenches, thermalization and many-body localization*
E. Canovi, D. Rossini, R. Fazio, G. Santoro, and A. Silva
Phys. Rev. B **83**, 094431 (2011)

33) *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])

34) *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)

35) *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)

36) *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

37) *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)

38) *Negative differential conductivity in far-from-equilibrium quantum spin chains*
G. Benenti, G. Casati, T. Prosen, and D. Rossini
Europhys. Lett. **85**, 37001 (2009)

39) *Photon and polariton fluctuations in arrays of QED-cavities*
D. Rossini, R. Fazio, and G. Santoro
Europhys. Lett. **83**, 47011 (2008)

40) *Spin chain model for correlated quantum channels*
D. Rossini, V. Giovannetti, and S. Montangero
New J. Phys. **10**, 115009 (2008)

41) *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)

42) *Robust and efficient generator of almost maximal multipartite entanglement*
D. Rossini and G. Benenti
Phys. Rev. Lett. **100**, 060501 (2008)

43) *Mott-insulating and glassy phases of polaritons in 1D arrays of coupled cavities*
D. Rossini and R. Fazio
Phys. Rev. Lett. **99**, 186401 (2007)

44) *Decoherence induced by interacting quantum spin baths*
D. Rossini, T. Calarco, V. Giovannetti, S. Montangero, and R. Fazio
Phys. Rev. A **75**, 032333 (2007)

45) *Information transfer rates in spin quantum channels*
D. Rossini, V. Giovannetti, and R. Fazio
Int. J. Quant. Inf. **5**, 439 (2007)

46) *Conservative chaotic map as a model of quantum many-body environment*
D. Rossini, G. Benenti, and G. Casati
Phys. Rev. E **74**, 036209 (2006)

47) *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]

48) *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)

49) *From perfect to fractal transmission in spin chains*
G. De Chiara, D. Rossini, S. Montangero, and R. Fazio
Phys. Rev. A **72**, 012323 (2005)

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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 intereste 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 have been coordinating the numerical work in the "*Condensed matter and quantum information theory*" group in Pisa. I am a developer of 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.