Gianluca Passarelli

Curriculum Vitae

Past affiliations

- Dipartimento di Fisica "E. Pancini", Università degli studi di Napoli "Federico II", PhD student
- Istituto superconduttori, materiali innovativi e dispositivi (SPIN), CNR, Napoli, collaboration

Research interests

Abstract The focus of my research is on adiabatic quantum computation, quantum annealing and open quantum systems. Using tools such as the Lindblad master equation, Lanczos exact diagonalization and Monte Carlo methods, I investigate the dissipative dynamics of physical quantum annealers to help understand their working principles and design better algorithms. Most of my activity involves programming efficient codes in Fortran 90, Python, Mathematica or MATLAB for simulating quantum dynamics, which would benefit from the usage of hybrid GPU/CPU architectures to speed up computation. I also have experience in genetic optimization using Python.

My network

ORCID `https://orcid.org/0000-0002-3292-0034`

ResearchGate `https://www.researchgate.net/profile/Gianluca_Passarelli2`

Google Scholar `https://scholar.google.com/citations?user=B68EAq8AAAAJ&hl=it`

Education

2018–2021 **Ph. D. in physics**, *Università degli studi di Napoli "Federico II"*, Napoli, 04/06/21.
Ottimo cum laude

2014–2017 **M. Sc. Degree in condensed matter physics**, *Università degli studi di Napoli "Federico II"*, Napoli, 19/07/2017.
110/110 cum laude

2011–2014 **Bachelor Degree in physics**, *Università degli studi di Napoli "Federico II"*, Napoli, 17/12/2014.
110/110 cum laude

Ph. D. thesis

Title *Quantum annealing and advanced optimization strategies of closed and open quantum systems*

Supervisors Prof. Vittorio Cataudella, Dr. Procolo Lucignano

Abstract Adiabatic quantum computation and quantum annealing are powerful methods designed to solve optimization problems more efficiently than classical computers exploiting slow quantum evolutions and a smart encoding of the solution into the ground state of Ising Hamiltonians. In physical quantum processors, the evolution lasts a finite amount of time, affected by Landau-Zener diabatic transitions, and unravels in the presence of an environment, inducing thermal excitations outside of the ground state. Both these limitations have to be carefully addressed in order to understand the true potential of these devices. The present thesis aims to find strategies to overcome these limitations, either by leveraging dissipation in a favorable way by exploiting novel annealing schemes (reverse annealing, quantum annealing with pauses), or by designing shortcuts to adiabaticity via counterdiabatic driving so as to minimize the impact of the environment on the dynamics.

Master thesis

Title *Adiabatic quantum annealing of simple NP-complete problems*

Supervisors Prof. Vittorio Cataudella, Prof. Giulio De Filippis, Dr. Procolo Lucignano

Abstract Quantum annealing is a modern protocol for solving complex optimization problems more efficiently than classical algorithms. This quantum strategy is employed in commercially available quantum processors, the D-Wave machines. However, these devices unavoidably interact with their surrounding environment, which may reduce the probability of success of the algorithm. This motivated our work, whose primary goal is to describe the impact of thermal noise on the performance of the annealing procedure. To this end, we focus on the ferromagnetic p-spin model, a prototypical optimization task. Contrarily to common belief, we show that dissipation can be beneficial for quantum annealing at low temperatures.

Pre-university studies

2006–2011 **Secondary school diploma**, *Liceo scientifico statale "A. Nobel"*, Torre del Greco (NA), Scientific certificate.
100/100 cum laude

Conferences and Schools

22/06/2021–25/06/2021 **AQC 2021**, *see https://aqc2021.org/index.html*, oral presentation.

15/03/2021–19/03/2021 **APS March meeting 2021**, *see https://march.aps.org*, oral presentation.

05/10/2020–06/10/2020 **Conference on Quantum Annealing/Adiabatic Quantum Computation**, *see http://indico.ictp.it/event/9119/*.

28/09/2020–02/10/2020 **Young Italian Quantum Information Science conference**, *see https://agenda.infn.it/event/23347/*, poster.

25/11/2019–29/11/2019 **Tensor Network-Based Approaches to Quantum Many-Body Systems (Donostia-San Sebastian)**, *see http://tensor2019.dipc.org*, poster.

15/09/2019–22/09/2019 **Quantum Technologies School (Ischia)**, *see https://indico.unina.it/event/24/page/35-venue*, oral presentation.

17/09/2018–20/09/2018 **Italian Quantum Information Science conference**, *see http://www.iqis2018.imm.cnr.it/*, oral presentation + poster.

15/04/2018–22/04/2018 **Capri Spring School on Transport in Nanostructures**, *see http://www.capri-school.eu/*.

Languages

Italian Mother tongue

English Proficient *CPE: Proficiency (C2 certificate)*

Computer skills

Intermediate Bash scripting, Python, C, C++, openMP/MPI paradigms

Advanced Fortran 90, Wolfram Mathematica, MATLAB, LaTeX

Journal refereeing and editing

2020–present **Physical Review Research**, *see https://journals.aps.org/prresearch/*, Referee.

2020–present **Physical Review X Quantum**, *see https://journals.aps.org/prxquantum/*, Referee.

2020–present **Physical Review A**, *see https://journals.aps.org/pra/*, Referee.

2018–present **Quantum machine intelligence (Springer)**, *see https://www.springer.com/engineering/computational+intelligence+and+complexity/journal/42484*, Referee.

Past activities

- Private tutoring in Mathematics, Physics, Computer Science, for high-school students

- Private tutoring in Mathematics (Calculus I and II), Physics (Mechanics, Thermodynamics, Electromagnetism, Quantum Mechanics, Condensed Matter Physics), Computer Science, for college students
- Tutoring in Physics for ADI - Associazione Didattica Integrativa

Scientific publications

[1] D. Rattacaso, **G. Passarelli**, A. Mezzacapo, P. Lucignano, and R. Fazio. "Optimal parent Hamiltonians for time-dependent states". In: *arXiv e-prints*, arXiv:2105.10187 (2021).

[2] **G. Passarelli**, V. Cataudella, R. Fazio, and P. Lucignano. "Counterdiabatic driving in the quantum annealing of the *p*-spin model: A variational approach". In: *Phys. Rev. Research* 2 (1 2020), p. 013283.

[3] **G. Passarelli**, K.-W. Yip, D. A. Lidar, H. Nishimori, and P. Lucignano. "Reverse quantum annealing of the *p*-spin model with relaxation". In: *Phys. Rev. A* 101 (2 2020), p. 022331.

[4] G. Acampora, V. Cataudella, P. R. Hegde, P. Lucignano, **G. Passarelli**, and A. Vitiello. "An evolutionary strategy for finding effective quantum 2-body Hamiltonians of *p*-body interacting systems". In: *Quantum Machine Intelligence* 1.3 (2019), pp. 113–122.

[5] L. M. Cangemi, **G. Passarelli**, V. Cataudella, P. Lucignano, and G. De Filippis. "A Numerically Exact Method for Dissipative Dynamics of Qubits". In: *Proceedings* 12.1 (2019).

[6] **G. Passarelli**, V. Cataudella, and P. Lucignano. "Improving quantum annealing of the ferromagnetic *p*-spin model through pausing". In: *Phys. Rev. B* 100 (2 2019), p. 024302.

[7] **G. Passarelli**, G. De Filippis, V. Cataudella, and P. Lucignano. "May a Dissipative Environment Be Beneficial for Quantum Annealing?" In: *Proceedings* 12.1 (2019).

[8] L. M. Cangemi, **G. Passarelli**, V. Cataudella, P. Lucignano, and G. De Filippis. "Beyond the Born-Markov approximation: Dissipative dynamics of a single qubit". In: *Phys. Rev. B* 98 (18 2018), p. 184306.

[9] **G. Passarelli**, G. De Filippis, V. Cataudella, and P. Lucignano. "Dissipative environment may improve the quantum annealing performances of the ferromagnetic *p*-spin model". In: *Phys. Rev. A* 97 (2 2018), p. 022319.