Antonio Anna Mele

Curriculum Vitae

Birth date: 22/08/1997
Nationality: Italian
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Short profile

Current status	PhD student at Freie Universität Berlin, Jens Eisert group.
Research interests	Theory of Quantum Information and Computing. Machine Learning and Theoretical Computer Science.
Website	`https://antonioannamele.com`

Education

2021 – Now **PhD in Quantum Information**, Freie Universität Berlin.
Advisor: Jens Eisert

2019 – 2021 **Master degree in Physics**, Double degree UNITN-SISSA.
University of Trento, Trento. *SISSA/ISAS - International School for Advanced Studies*, Trieste.
Final grade: 110/110 cum Laude, 20/10/2021. *Exams average*: 30/30 (maximum).

2016 – 2019 **Bachelor degree in Physics**, *University of Pisa*, Pisa.
Final grade: 110/110 cum Laude, 27/06/2019.

Academic papers (Google Scholar)

- PAC-learning of free-fermionic states is NP-hard. L.Bittel, **A.A. Mele**, L.Leone, J. Eisert. ArXiv preprint, arXiv:2404.03585, 2024.
- Noise-induced shallow circuits and absence of barren plateaus. **A.A. Mele**, A. Angrisani, S. Ghosh, S. Khatri, J. Eisert, D.S. França, Yihui Quek. ArXiv preprint, arXiv:2403.13927, 2024.
- Efficient learning of quantum states prepared with few fermionic non-Gaussian gates. **A.A. Mele**, Y. Herasymenko. ArXiv preprint, arXiv:2402.18665, 2024.
- Learning fermionic correlations by evolving with random translationally invariant Hamiltonians. J. Denzler, **A.A. Mele**, E. Derbyshire, T. Guaita, J. Eisert. ArXiv preprint arXiv:2309.12933, 2023.
- Introduction to Haar Measure Tools in Quantum Information: A Beginner's Tutorial. **A.A. Mele**. ArXiv preprint, arXiv:2307.08956, 2023.
- Exploiting symmetry in variational quantum machine learning. J.J. Meyer, M. Mularski, E. Gil-Fuster, **A.A. Mele**, F. Arzani, A. Wilms, J. Eisert. PRX Quantum 4 (1), 010328, 2023.
- Avoiding barren plateaus via transferability of smooth solutions in Hamiltonian Variational Ansatz. **A.A. Mele**, G.B. Mbeng, G.E. Santoro, M. Collura, P. Torta. Physical Review A 106 (6), L060401, 2022
- Stochastic noise can help to avoid saddle points in variational quantum algorithms. J. Liu, F. Wilde, **A.A. Mele**, L. Jiang, J. Eisert. ArXiv preprint, arXiv:2210.06723, 2022.

Teaching

2022 – 2023 Quantum information theory (tutorials). `https://antonioannamele.com/teaching/`

Talks and Poster

04/2024 Noise-induced shallow circuits and absence of barren plateaus. Centre for Quantum Technologies, National University of Singapore (Invited talk).

04/2024 Noise-induced shallow circuits and absence of barren plateaus. BraQIIIT lab at IIIT-Delhi (Invited talk).

02/2023 Avoiding barren plateaus via transferability of smooth solutions in Hamiltonian Variational Ansatz. QIP 2023 (poster).

09/2022 Avoiding barren plateaus via transferability of smooth solutions in Hamiltonian Variational Ansatz. DPG conference (talk).

09/2021 Exploiting symmetry in variational quantum machine learning. DPG conference (talk).

11/2022 Avoiding barren plateaus via transferability of smooth solutions in Hamiltonian Variational Ansatz. QTML 2022 (Extendend talk).

Partecipation in Schools and Workshops

08/2023 QMATH Masterclass on Quantum Learning Theory, University of Copenhagen.

07/2023 PCMI 2023 Graduate Summer School in Quantum Computation. IAS/Park City Mathematics Institute.

08/2022 QMATH Masterclass on Entropy Inequalities in Quantum Information Science, University of Copenhagen.

Review activity

Journals Quantum, npj Quantum Information.

Conferences QIP 2024, TQC 2023, QIP 2023, QTML 2022.

Current research interests

I am interested in various mathematical aspects of quantum information and computing. For example, I like to think about questions related to **quantum learning theory**, the **impact of noise** on quantum devices, and the **classical simulability** of classes of quantum states.

Bachelor and Master thesis

Master Title: Quantum Approximate Optimization Algorithm for Quantum Many-Body States Preparation.
Advisors: Mario Collura & Philipp H.J. Hauke.

Bachelor Title: How to break down quantum noise in a gravitational waves detector.
Advisor: Giancarlo Cella.

Master courses

During my master degree, I had the opportunity to attend various PhD courses in SISSA, in addition to the master courses in University of Trento, including:

UNITN:

- Statistical mechanics (30L/30) - R. Potestio
- Experimental methods (30/30) - S. Vitale
- Quantum Field Theory I (30/30) - A. Perego
- Quantum Mechanics, fields and symmetries (30/30) - W. Leidemann
- Nuclear and subnuclear physics (30L/30) - W. Leidemann
- Solid state physics I (30L/30) - G. Baldi
- Computational physics (30/30) - F. Pederiva
- Quantum computing (30L/30) - P. Hauke
- Quantum Machine Learning (30/30) - D. Pastorello
- General relativity and Cosmology (Attended course) - M. Rinaldi

SISSA:

- Many-Body Simulations I. Stochastic methods: from Langevin dynamics to Quantum Monte Carlo (30/30) - S. Sorella
- Many-Body Simulations II. Exact and Renormalisation methods: from Lanczos to Tensor Networks (28/30) - M. Collura
- Electronic bands and phonon dispersions: theory and applications (30L/30) - A. Dal Corso

- Quantum Many Body Systems and Strongly Correlated Electrons I (30L/30) - M. Capone
- Quantum Many Body Systems and Strongly Correlated Electrons II (30L/30) - M. Fabrizio
- The quantum Ising chain for beginners (30L/30) - G. Santoro
- Hubbard model dynamical correlation function via Lanczos Techniques (30L/30) - M. Collura
- Application of basic quantum Monte Carlo methods to a toy model on a lattice (30/30) - S. Sorella
- Entanglement Entropy and Quantum Field Theories (30/30) - P. Calabrese
- Algorithmic differentiation for electronic simulations (Attended course) - S. Sorella
- Introduction to Quantum Information and Computation (30L/30) - G. Santoro, R. Fazio
- Machine Learning for Material Science (30/30) - S. De Gironcoli

Computer Skills

Languages and Softwares: Python, C/C++, Fortran, Mathematica, HTML, CSS.

Frameworks for Quantum Computing e.g. *QisKit*, *Pennylane*, *CirQ*.

Good Arduino skills (plus, implemented a robotic hand as project for high school thesis).

Video-editing: Final Cut Pro.

Languages

Italian: Native.

English: Advanced. Master and PhD programme in English. FCE certificate.

German: Basic knowledge.

Experiences and Awards

2019 **UNITN-SISSA**: Scholarship for admission to Master Programme. Selected through a competition based on a physics written and oral exam.

2018-2019 **Lead The Future**: Selected as Mentee in *LeadTheFuture*. With the acceptance rate below 20 %, it is an organization that empowers top-performing students to achieve their goals by providing prestigious mentorship coming from the world's leading STEM innovation hubs such as Silicon Valley and CERN.

2015 **Physics, Chemistry and Informatics Olympiad**: Partecipation at the national finals of the National Informatics Olympiad and at both the regional phases of Physics and Chemistry olympiads.

2015-2016 **IoStudio**: Competition of MIUR and SAMSUNG. Winner for programming an Android App for my high school.

Other Experiences

- Representative of high school student body for two years (2014-15 and 2015-16).
- FIGC football referee (2014-15).
- Math, physics and programming mentor for students.