



Emanuele Polino

Education

2019–Present **Post-doc**, *Sapienza Università di Roma, Quantum Lab Group*, Rome, Italy.

2016–2019 **PhD student in Physics**, *XXXII cycle, Sapienza Università di Roma, Quantum Lab Group*, Rome, Italy.

Phd Thesis Project

Title *Photonic technologies for fundamental tests of quantum mechanics*

Supervisor Fabio Sciarrino

Description The aim of this thesis is to develop and implement different photonic platforms in order to realize fundamental tests of quantum features.

2013–2016 **Master degree in Physics**, *Sapienza Università di Roma*, Rome, Italy.
110/110 cum laude

Masters Thesis

Title *Interferometria quantistica a più particelle*

Supervisor Fabio Sciarrino

Description This thesis describes the experimental realization of a platform able to generate states of photons entangled in their wave and particle behaviors.

2010–2013 **Bachelor degree in Physics**, *Sapienza Università di Roma*, Rome, Italy.
110/110 cum laude

2005–2010 **High School Diploma**, *Liceo Scientifico Benedetto Croce*, Rome, Italy.
100/100

Awards

- 2018-2019 *Progetti per Avvio alla Ricerca* offered by Sapienza Università di Roma (importo: 1200 Euro)
- 2016-2019 *Borsa di Dottorato* offered by Sapienza Università di Roma
- 2010-2013 *Percorso di Eccellenza*, lectures addressed to outstanding bachelor students of Physics Department
- 2010-2012 University taxes exoneration *Studente Meritevole*

Outreach activities

- 2016-2019 **Member of OSA La Sapienza Student chapter**, The chapter is supported by the american society OSA (The Optical Society).
- 2017-2019 **Treasurer of SPIE La Sapienza Student Chapter**, The chapter is supported by the american society SPIE (Society of Photo-Optical Instrumentation Engineers).
- 2016-2019 **Member of RAYS**, RAYS (Rome Association of Young Scientist) is a group of PhD students and master students in physics devoted to scientific divulgation and outreach activities..
- 3rd April 2019 **Organization with RAYS of the workshop *Quantum Leap: from Academia to industry***, event with the goal to give an overview over the job opportunities after PhD studies..
- 14-16th October 2016 **Participation to the event Maker Faire 2016 with RAYS**, supported by OSA and SPIE, Rome, Italy.

Attended Projects

- **CAPABLE** (2018-2019): Composite integrated photonic platform by femtosecond laser micro-machining, Funding programme: ERC Advanced Grant 2016
- **QUCHIP** (2017-2018): Quantum Simulation on a Photonic Chip, Funding programme: FETPROACT-3-2014: Quantum simulation
- **3D-QUEST** (2017): 3D-Quantum Integrated Optical Simulation, Funding programme: ERC Starting Grant-Consolidator
- **QISS** (2019-Present): Quantum Information Structure of Spacetime

Collaborations

- Group led by Prof. **Rafael Chaves** in International Institute of Physics, Universidade Federal do Rio Grande do Norte, Natal, Brazil.
- Prof. **Robert Spekkens** in Perimeter Institute, Waterloo, Ontario, Canada.
- Prof. **Elie Wolfe** in Perimeter Institute, Waterloo, Ontario, Canada.
- Group led by Prof. **Mauro Paternostro** in Queen's University, Belfast, Ireland.
- Prof. **Rosario Lo Franco** in Università degli Studi di Palermo, Palermo, Italy.
- Group led by Prof. **Roberto Osellame** in Politecnico di Milano, Milan, Italy.
- Group led by Prof. **Marco Barbieri** in Roma Tre university, Rome, Italy.
- Prof. **Lorenzo Marrucci** in Università degli studi di Napoli Federico II, Naples, Italy.
- **Nathan Wiebe** Researcher at Microsoft Research in the Quantum Architectures and Computing Group, Seattle, Washington.

- Group led by Prof. **Leif Katsuo Oxenløwe** in Technical University of Denmark, Kongens Lyngby, Denmark.
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Computer skills

Operating systems	Linux, Microsoft Windows
Languages	C/C++, PYTHON
Graphics	Inkscape
Other softwares	Mathematica, LabView, $\text{\LaTeX}$, Microsoft Office package

Languages

Italian	Mothertongue
English	Fluent

Attended Schools and Conferences

- *QISS HKU Workshop 2020* 13-17/01/2020, Hong Kong.
- *Causality in the quantum world: harnessing quantum effects in causal inference problems* 17-20/09/2019, Anacapri, Italy.
- *Solstice of Foundations Summer School* 17-21/06/2019, Zurich, Switzerland.
- *Quantum Measurement: Fundamentals, Twists, and Applications* 29/04 - 04/05 /2019, Trieste, Italy.
- *Quantum Information and Measurement* 4-6/04/2019, Rome, Italy.
- *Modern Topics in Quantum Information* 06-10/08/2018, Natal, Brazil.
- *Quantum Roundabout 2018* 11-13/07/2018, Nottingham, United Kingdom.
- *103-esimo Congresso nazionale Società Nazionale di Fisica* 11-15/09/2017, Trento, Italy.
- *Foundations of quantum mechanics and their impact on contemporary society* 11-12/12/2017, London, United Kingdom.
- *Solstice of Foundations Summer School* 18-23/06/2017, Zurich, Switzerland.
- *Winter school on Complex Networks: From Classical to Quantum, Theory and Experimental Implementation* 03-07/04/2017, Obergurgl, Austria.
- *Scientific School: Architectures for Quantum Photonic Circuits* 08-10/02/2017, Nice, France.

Conference Presentations

- **Oral contribution:** "*Device independent certification of a quantum Delayed Choice Experiment*", Modern Topics in Quantum Information, 06-10/08/2018, Natal, Brazil.
- **Oral contribution:** "*Device independent certification of a quantum Delayed Choice Experiment*", Modern Topics in Quantum Information, 06-10/08/2018, Natal, Brazil.
- **Oral contribution:** "*Experimental Phase Estimation enhanced by Machine Learning*", Quantum Roundabout 2018, 11-13/07/2018, Nottingham, United Kingdom.
- **Oral contribution:** "*Entanglement of photons in their dual wave-particle nature*", 103-esimo Congresso nazionale Società Nazionale di Fisica, 11-15/09/2017, Trento, Italy.
- **Oral contribution:** "*Quantum multiphase estimation in an integrated photonic circuit*", YIQIS 2020, 28/09-02/10/2020, online event Europe/Rome.
- **Poster contribution:** "*Device independent certification of a quantum Delayed Choice Experiment*", Solstice of Foundations Summer School, 17-21/06/2019, Zurich, Switzerland.
- **Poster contribution:** "*Device independent certification of a quantum Delayed Choice Experiment*", Quantum Measurement: Fundamentals, Twists, and Applications, 29/04-04/05/2019, Trieste, Italy.
- **Poster contribution:** "*Machine Learning For Experimental Single Shot Phase Estimation*", Quantum Information and Measurement, 4-6/04/2019, Rome, Italy.
- **Poster contribution:** "*Entanglement of photons in their dual wave-particle behaviour*", Foundations of quantum mechanics and their impact on contemporary society, 11-12/12/2017, London, United Kingdom.
- **Poster contribution:** "*Entanglement of photons in their dual wave-particle behaviour*", Solstice of Foundations Summer School, 18-23/06/2017, Zurich, Switzerland.

Publications

- **E. Polino**, I. Agresti, D. Poderini, G. Carvacho, G. Milani, G. Barreto Lemos, R. Chaves, and F. Sciarrino, Device-Independent test of a delayed choice experiment, *Phys. Rev. A*, **100**, 022111 (2019)
- **E. Polino**, M. Riva, M. Valeri, R. Silvestri, G. Corrielli, A. Crespi, N. Spagnolo, R. Osellame, and F. Sciarrino, Experimental multiphase estimation on a chip, *Optica* **6**, 288-295 (2019)
- D. Poderini, I. Agresti, G. Marchese, **E. Polino**, T. Giordani, A. Suprano, M. Valeri, G. Milani, N. Spagnolo, G. Carvacho, R. Chaves, and F. Sciarrino, "Experimental violation of n-locality in a

star quantum network", *Nature communications*, 11 (1), 1-8, 2020.

- K. Rambhatla, S. E. D'Aurelio, M. Valeri, **E. Polino**, N. Spagnolo, and F. Sciarrino, Adaptive phase estimation through a genetic algorithm, *Phys. Rev. Research* 2, 033078 (2020)
- T. Giordani, **E. Polino**, S. Emiliani, A. Suprano, L. Innocenti, H. Majury, L. Marrucci, M. Paternostro, A. Ferraro, N. Spagnolo, and F. Sciarrino, Experimental engineering of arbitrary qudit states with discrete-time quantum walks, *Phys. Rev. Lett.* **122**, 020503 (2019)
- A. Lumino, **E. Polino**, A.S. Rab, G. Milani, N. Spagnolo, N. Wiebe, and F. Sciarrino (*Editors' Suggestion*) Experimental phase estimation enhanced by machine learning, *Phys. Rev. Applied* **10**, 044033 (2018)
- I. Gianani, **E. Polino**, M. Sbroscia, A.S. Rab, E. Roccia, L. Mancino, N. Spagnolo, M. Barbieri, and F. Sciarrino, Hong-Ou-Mandel control through spectral shaping, *J.Opt.* **20**, 085201 (2018)
- S. Atzeni, A.S. Rab, G. Corrielli, **E. Polino**, M. Valeri, P. Mataloni, N. Spagnolo, A. Crespi, F. Sciarrino, and R. Osellame, Integrated sources of entangled photons at the telecom wavelength in femtosecond-laser-written circuits, *Optica* **5**, 311-314 (2018)
- T. Giordani, A. Suprano, **E. Polino**, F. Acanfora, L. Innocenti, A. Ferraro, M. Paternostro, N. Spagnolo, and F. Sciarrino, "Machine learning-based classification of vector vortex beams", *Physical Review Letters*, 124 (16), 160401, (2020)
- A.S. Rab, **E. Polino**, Z.-X. Man, N.B. An, Y.-J. Xia, N. Spagnolo, R. Lo Franco, and F. Sciarrino, Entanglement of photons in their dual wave-particle nature, *Nat. Commun.* **8**, 915 (2017)
- D. Cozzolino, **E. Polino**, M. Valeri, G. Carvacho, D. Bacco, N. Spagnolo, L. K.Oxenløwe, and F. Sciarrino, Air-core fiber distribution of hybrid vector vortex-polarization entangled states, *Advanced Photonics*, vol. 1, no. 4, p. 046005, (2019)
- **E. Polino**, M. Valeri, N. Spagnolo, and F. Sciarrino, *Photonic quantum metrology*, *AVS Quantum Scienc* no. 2, 02470 (2020)
- V. Cimini, **E. Polino**, M. Valeri, I. Gianani, N. Spagnolo, G. Corrielli, A. Crespi, R. Osellame, M. Barbieri and F. Sciarrino, *Calibration of Multiparameter Sensors via Machine Learning at the Single-Photon Level*, *Physical Review Applied* 15.4 044003, (2021)
- M. Valeri, **E. Polino**, D. Poderini, I. Gianani, G Corrielli, A Crespi, R Osellame, N. Spagnolo, and F. Sciarrino, *Experimental adaptive Bayesian estimation of multiple phases with limited data*, *npj Quantum Information* 6.1 1-11, (2020)
- T. Giordani, L. Innocenti, A. Suprano, **E. Polino**, M. Paternostro, N. Spagnolo, F. Sciarrino, and A. Ferraro, *Entanglement transfer, accumulation and retrieval via quantum-walk-based qubit-qudit dynamics*, *New Journal of Physics*, 23(2), 023012, (2021)

- A. Suprano, D. Zia, **E. Polino**, T. Giordani, L. Innocenti, M. Paternostro, A. Ferraro, N. Spagnolo, and F. Sciarrino, *Enhanced detection techniques of orbital angular momentum states in the classical and quantum regimes*, New Journal of Physics, 23(2), 023012, (2021)
- I. Agresti, B. Polacchi, D. Poderini, **E. Polino**, A. Suprano, I. Supic, J. Bowles, G. Carvacho, D. Cavalcanti, and F. Sciarrino, *Experimental robust self-testing of the state generated by a quantum network*, PRX Quantum, 2(2), 020346 (2021)

Pre-prints

- R. Chaves, G. Moreno, **E. Polino**, Davide Poderini, I. Agresti, A. Suprano, M. R. Barros, G. Carvacho, E. Wolfe, A. Canabarro, R. W. Spekkens, and F. Sciarrino, *Causal networks and freedom of choice in Bell's theorem*, arXiv preprint arXiv:2105.05721 (2021)
- I. Agresti, D. Poderini, B. Polacchi, N. Miklin, M. Gachechiladze, A. Suprano, **E. Polino**, G. Milani, G. Carvacho, R. Chaves, and F. Sciarrino, *Experimental test of quantum causal influences*, arXiv preprint arXiv:2108.08926 (2021)
- V. Cimini, **E. Polino**, F. Belliardo, F. Hoch, B. Piccirillo, N. Spagnolo, V. Giovannetti, and F. Sciarrino, *Non-asymptotic Heisenberg scaling: experimental metrology for a wide resources range*, arXiv preprint arXiv:2110.02908 (2021)
- G. Carvacho, E. Roccia, M. Valeri, F. Basso Basset, D. Poderini, C. Pardo, **E. Polino**, L. Carosini, M. B. Rota, J. Neuwirth, S. F. Covre da Silva, A. Rastelli, N. Spagnolo, R. Chaves, R. Trotta, and F. Sciarrino *Quantum violation of local causality in urban network with hybrid photonic technologies*, arXiv preprint arXiv:2109.06823 (2021)
- D. Poderini, **E. Polino**, G. Rodari, A. Suprano, R. Chaves, and F. Sciarrino *Ab-initio experimental violation of Bell inequalities*, arXiv preprint arXiv:2108.00574 (2021)

Proceedings Contributions

- **E. Polino**, N. Spagnolo, F. Sciarrino, G Corrielli, A Crespi, and R Osellame, *Platforms for telecom entangled photon sources*, "E. Fermi" International School of Physics, "Nanoscale Quantum Optics", 204, 85, (2020)
- T. Giordani, **E. Polino**, S. Emiliani, A. Suprano, N. Spagnolo, F. Sciarrino, L. Innocenti, H. Majury, M. Paternostro, A. Ferraro, L. Marrucci, *Engineering of Quantum States through Quantum Walk in the Angular Momentum*, Quantum Information and Measurement, F5A. 48 (2019)
- A.S. Rab, **E. Polino**, M. Valeri, P. Mataloni, N. Spagnolo, F. Sciarrino, S. Atzeni, G Corrielli, A. Crespi, and R. Osellame, *Integrated source of entangled photon pair at telecom wavelength*, Quantum Information and Measurement, T5A. 8 (2019)
- **E. Polino**, A. Lumino, A.S. Rab, G. Milani, N. Spagnolo, F. Sciarrino, and N. Wiebe, *Machine Learning For Experimental Single Shot Phase Estimation*, Quantum Information and Measurement, T5A. 41 (2019)

- D. Cozzolino, **E. Polino**, M. Valeri, G. Carvacho, D. Bacco, N. Spagnolo, L. K. Oxenlowe, and F. Sciarrino, *Towards hybrid entanglement distribution with an orbital angular momentum supporting fiber*, Quantum Information and Measurement, T5A. 56 (2019)
- S. Atzeni, A. Crespi, G. Corrielli, R. Osellame, A.S. Rab, **E. Polino**, M. Valeri, P. Mataloni, N. Spagnolo, F. Sciarrino, Versatile integrated source of entangled photons at telecom wavelength in femtosecond-laser-written circuits, Advances in Photonics of Quantum Computing, Memory, and Communication XI , 105470Y (2018)

Addressed Topics

- **Quantum nonlocality**: experimental implementation of different causal structure in which quantum systems show nonlocality. Implementation of a star-shaped quantum network with up to 5 nodes.
- **Quantum foundations studies on wave-particle duality**: generation of pairs of photons entangled in their dual wave and particle behaviours; experimental realization of a delayed choice experiment studied in a causal framework and proved to be non-classical through violations of device-independent dimensional witnesses.
- **Generation, Transmission and Measurement of quantum states of photons carrying orbital angular momentum**: generation of arbitrary qudit states encoded in the angular orbital momentum of single photons, through a 5-step discrete-time quantum walk; transmission of hybrid polarization-vector vortex entangled photon pairs, exploiting an air-core fiber which supports orbital angular momentum modes; experimental classification of vector-vortex beams exploiting machine learning techniques.
- **Quantum metrology**: realization of single phase estimation in a Mach-Zehnder interferometer exploiting machine learning techniques in order to enhance the estimation process in presence of limited resources; study of an integrated circuit, realized through the femtosecond laser-writing technique, for quantum multiphase estimation in a three-arm interferometer.
- **Sources of entangled photon pairs**: realization of noncollinear single photon sources generating polarization entangled photon pairs at $785nm$ wavelength; entangled sources based on Sagnac interferometer at $785nm$ or $1550nm$ wavelengths, exploiting periodically poled crystals; integrated source, realized through femtosecond laser-writing technique, generating entangled photons in polarization or path degrees of freedom at $1550nm$ wavelength.