Danilo Zia

ABOUT ME

I am a first year PhD student at Sapienza - University of Rome. I graduated at this University in October 2020 with a final grade of 110/110 cum laude. In my thesis I worked on a project in the field of Quantum Information within the “Quantum Information Lab” group headed by Professor Fabio Sciarrino. In this project I studied the engineering of quantum and classical states using a photonic platform. The latter is based on an experimental implementation of the quantum walk dynamics using the polarization and orbital angular momentum degrees of freedom of photons. In particular, the project focused on the development of an accurate model for the photon propagation inside the experimental setup. The use of this model enhanced the performances in the measurement of the orbital angular momentum of photons through the holographic technique, and in the recognition of vector vortex beams with a machine learning-based approach. Currently, I am working on an improvement of the experimental apparatus, used for the generation of orbital angular momentum states and vector vortex beams, with a black box machine learning-based optimization of the quantum walk step parameters. Moreover, I am investigating the propagation of orbital angular momentum beams inside tissue-mimicking scattering samples.

EDUCATION AND TRAINING PhD in Physics

Sapienza - University of Rome [2020 – Current]

Address: Piazzale Aldo Moro 5, 00185 Roma (Italy)

Master's Degree in Physichs

Sapienza - University of Rome [2018 – 2020]

Address: Piazzale Aldo Moro 5, 00185 Roma (Italy)
Final grade : 110/110 cum laude
Thesis: Machine learning classification of vector vortex beams

During my master's degree I gave the following exams:

Exam (SSD)	CFU	Mark
CONDENSED MATTER PHYSICS (FIS/03)	6	28/30
PHYSICS LABORATORY I (FIS/01)	6	30/30
RELATIVISTIC QUANTUM MECHANICS (FIS/02)	6	28/30
STATISTICAL MECHANICS AND CRITICAL PHENOMENA (FIS/02)	6	30 with honor/30

MATHEMATICAL PHYSICS (MAT/07)	6	30/30
PHYSICS LABORATORY II (FIS/01)	9	30 with honor/30
ATOMIC SIMULATIONS (INF/01)	6	29/30
NONLINEAR AND QUANTUM OPTICS (FIS/01)	6	30/30
QUANTUM ELECTRODYNAMICS (FIS/08)	6	30/30
ENGLISH LANGUAGE (-)	4	qualified
STATISTICAL MECHANICS OF DISORDERED SYSTEMS (FIS/02)	6	30 with honor/30
QUANTUM INFORMATION AND COMPUTATION (FIS/03)	6	30 with honor/30
PHYSICS OF COMPLEX SYSTEMS (FIS/03)	6	30 with honor/30

“Physics Laboratory II” dissertation title: Generation of Orbital Angular Momentum states at telecom wavelength using a Spatial Light Modulator

Bachelor's Degree in Physics

Sapienza - University of Rome [2015 – 2018]

Address: Piazzale Aldo Moro 5, 00185 Roma (Italy)

Final grade : 110/110

Thesis: Direct dark matter detection with noble liquid detectors

High School Diploma

Liceo Scientifico G. Piazzi [2010 – 2015]

Address: Via Campagnanese 3, 00067 Morlupo (Italy)

Final grade : 100/100

CERTIFICATES

Machine Learning

[20/07/2020]

Issued by Coursera - Stanford University

https://www.coursera.org/account/accomplishments/certificate/KAUR4U4K83RU

Cambridge ESOL Certificate

[12/07/2013]

Level B1

LANGUAGE SKILLS

Mother tongue(s): **Italian**

Other language(s): **English (Intermediate)**

SCIENTIFICSKILLS

Orbital Angular Momentum of light generation, manipulation and detection

During the "Physics Laboratory II" course, provided by Sapienza - University of Rome, and in my master's degree thesis I acquired experience in the generation, manipulation and detection of the orbital angular momentum of light using devices such as q-plates and spatial light modulators. In particular, in my thesis I investigated the engineering of orbital angular momentum states via an experimental platform based on the quantum walk dynamics and built up using a series of q-plates placed in a cascaded configuration. Since qplates change the orbital angular momentum value conditionally to the polarization, a set of waveplates are located between two consecutive q-plates in order to generate as output of the apparatus the wanted orbital angular momentum state. A setup composed by a spatial light modulator followed by a single mode fiber was used to measure the orbital angular momentum carried by the beam through an approach based on the holographic technique. Moreover, in order to improve the results of this measurement approach an accurate model for the beam propagation inside the setup was developed. This allowed me to deepen the study about the description of orbital angular momentum beams, in particular about Laguerre-Gaussian and Hypergeometric-Gaussian modes.

Machine Learning

I acquired knowledge about the basis of Machine Learning taking the online course held by Professor Andrew Ng on the Coursera platform. Following the recent interest for machine learning application in experimental scenario, especially for the case of structured light, in my thesis project I used a machine learning architecture called convolutional neural network to tackle a classification problem. In particular, I studied the recognition of experimentally generated vector vortex beams. These beams were divided in fifteen classes according to the different superposition of the orbital angular momentum states entangled with the polarization that characterizes each of them. As a matter of fact, different superpositions produce different colour patterns in RGB images of the vector vortex beams. The convolutional neural network was used to correctly classify these patterns and to extract the information stored in the orbital angular momentum and polarization degrees of freedom without the exploitation of lossy experimental architectures.

Quantum Information

During the second year of my master’s degree at Sapienza - University of Rome I acquired knowledge about the theoretical basis of Quantum Information following the "Quantum Information and Computation" course held by Professor Fabio Sciarrino. Moreover, in the "Physics Laboratory II" course and in my thesis project I worked on a photonic platform to encode information using the orbital angular momentum degree of freedom of photons both in classical and quantum regimes. The orbital angular momentum is an invaluable resource in quantum information since it permits to transmit with a single photon a large amount of information securely, allowing the development of higher security and capacity protocols in communication and cryptography. In the experimental setup single photons were generated with a heralding procedure that exploits a pair of entangled photons produced via spontaneous parametric down conversion by a nonlinear crystal placed in a Sagnac interferometer.

DIGITAL SKILLS

Microsoft Office / Wolfram programming language / Python programming language / C programming language / LaTeX

PUBLICATIONS

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"

[2021]

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