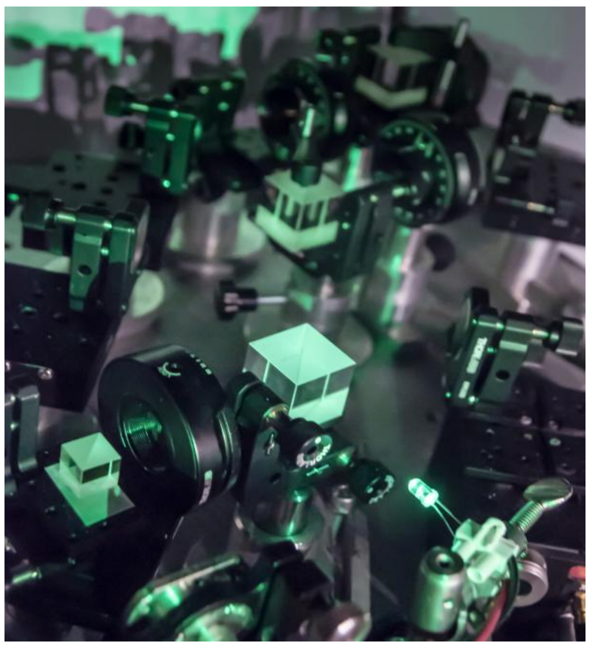
Q@TN
Seminar



Dr. Alessio Baldazzi

Dipartimento di Fisica, Università di Trento

A quantum variational integrated photonic solver

January 20, 2026 – h 14:00

Aula A109 – Povo 1 – Via Sommarive n. 5

Abstract:

Variational quantum algorithms (VQAs) are hybrid quantum-classical algorithms that are tailored to solve a specific task, characterized by a cost function. They involve a reconfigurable quantum system and a standard PC. The first element prepares trial states, whose measurement provides the data for the classical unit. Then, the PC computes the cost function of the problem and updates the preparation setting of the quantum unit through an optimization routine. The overall procedure is successful when the iterative exchange of data between the two components ends with the convergence of the cost function to an extreme value and the knowledge of the optimal preparation setting for the quantum system. VQAs are extensively studied for their potential to leverage near-term quantum hardware for computational advantages. Integrated photonics represents a promising platform for VQAs, since generating and detecting entangled photons can be done using room-temperature and well-established technology.

In the Nanoscience Laboratory, we designed and successfully validated a reconfigurable silicon photonic integrated circuit able to perform different VQAs at room temperature. The circuit is composed of robust and well-known photonic structures, combined to generate and manipulate entangled photon pairs. In particular, two entangled ququarts can be encoded in photon pairs generated with four identical spontaneous-four-wave-mixing-based integrated photon pair sources. The correlations of these photon pairs represent the resource for preparing generic trial states. A variational quantum eigensolver for the Hydrogen molecule and a variational quantum factorization for small semiprime numbers have been executed through our photonic circuit. Given its adaptability, the utilized circuit scheme has also been used to implement a novel VQA for the travelling salesman problem and a pair of photonic quantum memristors for quantum reservoir computing.

In my talk, I will show how photon pairs can encode information and how they can be used to solve specific tasks through tailored VQAs on our integrated photonic solver. Our result represents a first demonstration of VQAs on a photonic quantum simulator with integrated photon pair sources, and thus it marks a significant step toward a fully-integrated photonic quantum processor.

Contacts:
Staff Dipartimento di Fisica
0461 28-1219-1504-1575-2042
info.qtn@unitn.it

Scientific Coordinator:
Prof.ssa Sonia Mazzucchi
Dott. Georg Pucker

with the financial support of