Invited talks

Variational quantum algorithms

Alba Cervera-Lierta
Barcelona Supercomputing Center (BSC-CNS)

In this lecture, we will review the experimentally feasible algorithmic state-of-the-art quantum computation, namely the Noisy Intermediate-Scale Quantum algorithms (NISQ). Current quantum computers are composed of a few qubits that perform imperfect operations. The goal of NISQ algorithms is to leverage the limited available resources to perform classically challenging tasks, paving the way towards the long-awaited Fault-Tolerant quantum computation while seeking short and medium-term applications. NISQ algorithms present several challenges, both from experimental and theoretical points of view. We will review some of these challenges and learn the basics and applications of one of the leading representatives of NISQ: the Variational Quantum Algorithms.

Invited talks

Superconducting resonators for space and quantum applications

Alicia Gómez
Centro de Astrobiología CSIC-INTA

Superconducting microwave resonators are crucial elements in many quantum science and technology applications such as quantum electrodynamics circuitry, quantum sensing and astronomy detectors. Particularly, we are focused on the development of Lumped Element superconducting Resonators (LERs). LERs are high-quality factor resonators based on a series inductance-capacitance superconducting circuit coupled in parallel to a single transmission line.

Kinetic Inductance Detectors (KIDs) are state-of-the-art radiation detectors based on the change of the kinetic inductance of LERs when a photon interacts with them. We are employing these devices in millimeter and submillimeter astronomical experiments such as the study of the Cosmic Microwave Background (CMB) radiation which require a great number of extra-high sensitivity detectors arranged in large format cameras. The main advantage of KIDs over other types of detectors is that LER architecture allows to lay out thousands of resonators all of them easily integrated within a single transmission line. This passive frequency-domain multiplexing is especially useful providing the wide field of view necessary to map the CMB.

Resonators based on LERs are also a fundamental component for quantum computers circuitry. Their flexibility in design and compact nature implies a great advantage over distributed resonators regarding scalability, speed, and fidelity. Their recent introduction to spin-based quantum computation promises to enhance this research field. In particular, the highly intense magnetic field produced by LERs allows initializing qubits codified within small spin ensembles, which offer coherence times far larger than the superconducting qubits used in other quantum platforms. In the future, these developments will produce highly compact units even able to perform their own error correction protocols. Furthermore, the capability of multiplexing different LERs along a single transmission line allows interaction with different spin-based qubits at the same time.

In this talk, I will present our efforts on developing and optimizing LERs for its use as Kinetic Inductance Detectors for astronomical experiments and as building blocks for Molecular Spin on-chip Quantum Processors.

Invited talks

Topological Photonics

Alberto Amo
CNRS-University of Lille

Topology describes the properties of a physical system that remain unaffected under smooth distortions. When considering the electronic transport in solids, these properties are related to a topological invariant: a magnitude characterising the electronic bands and that can only take integer values. The value of the integer directly indicates the number of conducting channels at the edges of the solid, with transport properties robust to disorder and deformations. This paradigm has been able to successfully explain the universal transport of the quantum Hall effect and to predict the existence of topological insulators and Weyl semimetals.

When these concepts are brought to photonic lattices, a whole new playground appears for the design of photonic systems with robust channels for the transport of light in a chip. Moreover, the engineering of the hoppings between photonic resonators makes photonic lattices an excellent system to study fundamental topological properties inaccessible in electronic systems, and to develop new concepts such as non-Hermitian topology and topological lasers. In the context of Quantum Technologies and Quantum Computing, topological photonics provides new strategies to design quantum interconnects with very high fidelity.

Invited talks

Tensor Network States for the study of quantum many-body systems

Mari Carmen Bañuls
Max Planck Institute for Quantum Optics

The term Tensor Network (TN) States designates a number of ansatzes that can efficiently represent certain states of quantum many-body systems. In particular, they can be used to study numerically ground states and thermal equilibrium of local Hamiltonians, and, to some extent, real time evolution. Quantum information theory explains why they are suitable for physically relevant states, and why there are limitations connected to the simulation algorithms.

We can say that TN methods constitute quantum inspired algorithms for classical simulations. At the same time, they can be decisive tools to design and verify the near term quantum simulators. While originally introduced in the context of condensed matter physics, where they have become a state-of-the-art technique for strongly correlated one-dimensional systems, in the last years it has been shown that TNS are also suitable for a broad variety of problems.

Invited talks

Diamond-based quantum technologies for nanoscale sensing

Jorge Casanova
Universidad del País Vasco (UPV/EHU)

Quantum technologies for accurate detection of nuclei reached the scenario of room temperature. This opens the door of several interdisciplinary applications in condensed matter, chemistry, biology, and life-sciences. In this talk, I will review the state of the art of quantum sensing with nitrogen vacancy centers and discuss potential applications.

Oral contributions

Title of talk

Name
Affiliation

Bayesian network structure learning is an NP-hard problem that has been faced by a number of traditional approaches in recent decades. In this work, a specific type of variational quantum algorithm, the quantum approximate optimization algorithm, was used to solve the Bayesian network structure learning problem. Our results showed that the quantum approximate optimization algorithm approach offers competitive results with state-of-the-art methods and quantitative resilience to quantum noise. The approach was applied to a cancer benchmark problem.

Poster session 1

1. Guillermo Lugilde (University of Oviedo)
   Functional quantum abstract detecting systems

2. D.A. Quintero Dominguez (University of Bristol)
   A multiphysics modeling tool for engineering multiplexed single-photon sources

3. Tom Ewen (Fraunhofer ITWM)
   Option Pricing with the Quantum Fourier Transform

4. Sergio Martínez-Losa Del Rincón (UNIZAR/BIFI)
   Modification of MUMAX3 software for Macrospin-Cavity Interaction

5. Carlos Payá (Instituto de Ciencia de Materiales de Madrid)
   Theory of Caroli-de Gennes-Matricon analogs in full-shell hybrid nanowires

6. Amaya Calvo Sánchez (Imperial College London)
   Assessment of Quantum Gate Fidelities through Bayesian Estimation Methods

7. Carolina del Río (Universidad de Zaragoza)
   Engineering remote spin-spin interactions by superconducting circuit design

8. Chaibata Seida (ESMaR faculty of sciences Mohammed V university of Rabat Morocco)
   Non-local quantum operation

9. Gonzalo Salinas (NVISION)
   Quantum Computing for Everyday Users

10. Pablo Páez Velasco (UCM / ICMAT)
    Towards polynomial convergence for Variational Quantum Algorithms using Langevin Dynamics

11. D. García-Pons (Instituto de Nanociencia y Materiales de Aragón, INMA)
    Quantum Cavities based on Magnonic Textures

12. Jorge Pérez-Bailón (Instituto de Nanociencia y Materiales de Aragón, INMA)
    Controlled fabrication of Nb-based dayem bridge Josephson Junctions for highly-replicable SQUIDs

13. Marine Demarty (University of Edinburgh)
    Quantum Advantage Benchmarking - An Entropic Analysis

14. Nathan Moses (University of Bristol)
    2D Grating Couplers for Polarisation-based Entanglement Distribution Quantum Networks

15. Luis García Nnomo (Universidad Internacional Menéndez Pelayo, UIMP)
    Gaussian laser pulse generation for NV centres' spin initialization in Quantum Sensing experiments

16. Enrique Sánchez Ibáñez (Universidad Internacional Menéndez Pelayo, UIMP)
    tbd

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Poster session 2

1. Hannah Seabrook (University of Bristol)
"Noiseless" Quantum Key Distribution Protocol for Secure Communication across an Unknown Unitary Channel

2. Unai Aseguinolaza (Mondragon Unibertsitatea), Nahual Sobrino(Universidad del País Vasco EHU/UPV)
Error Estimation in IBM Quantum Computers

3. P. Alsina-Bolívar (University of the Basque Country)
Low field NMR at the microscale with nitrogen vacancy centers

4. Borja Varona (UPV/EHU)
Decoding 13C hyperfine parameters in NV centers signals with deep learning

5. Alejandro Andrés-Juanes (ISTA)
Entanglement of Two Distant Transmon Qubits Using Gaussian-correlated Beams

6. Alonso Hernández-Antón (ETH Zürich)
Generation of 2D tensor-network states of itinerant microwave photons

7. Pedro Mendes (Instituto de Telecomunicações)
Compact nanosatellite design of a downlink platform for quantum communication

8. Gonçalo Teixeira (Instituto Superior Técnico)
Performance simulation for a satellite downlink free-space quantum communication

9. Raúl Fuentes del Pino (Universidad Internacional Menéndez Pelayo (UIMP))
tbd

10. Pere Mujal (ICFO)
Time-Series Processing with Quantum Measurements

11. Daniel Centeno (Instituto de Física Teórica)
Photonic implementation of a quantum Morra game

12. Shalini Devendrababu (Universidad Internacional Menéndez Pelayo (UIMP))
Semiconductor quantum devices based on SiNW for detection of single charge

13. Srinjoy Ganguly (Universidad Internacional Menéndez Pelayo (UIMP))
Development of quantum devices based on superconductor-semiconductor nanowires

14. Ana Martin (Universidad del País Vasco)
Correlation spectroscopy for nanoscale NMR with nitrogen-vacancy centers

15. D. Michel Pino (Materials Science Institute of Madrid, ICMM-CSIC)
Minimal Kitaev-transmon qubit based on double quantum dots