R&D IN QUANTUM TECHNOLOGIES AT THE UPC

2023

Generalitat de Catalunya

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

CoFunded by the European Union

CONTENT

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01

THE UPC

The Universitat Politècnica de Catalunya - BarcelonaTech (UPC) is a public university dedicated to research and higher education in the fields of engineering, architecture, sciences and technology.

It has a significant presence and active involvement in the industrial centres of the region. The UPC actively participates in Catalonia's innovation system through research projects, contracts, knowledge valorisation and technology commercialisation efforts that address significant social challenges.

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RESEARCH, DEVELOPMENT AND INNOVATION ACTIVITY AT THE UPC 2022

227
Projectes nacionals

162
Projectes internacionals

€78,1 million
in project revenues

€121,9 million
In contracts revenues

2.526
articles in journals

331
Theses

14
registered patents

13
new Technology-Based Companies

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02

QUANTUM TECHNOLOGIES

Quantum technologies encompass a broad range of applications and disciplines that leverage the principles of quantum mechanics to develop new devices, systems and protocols.

Quantum technologies refer to any field that explores and utilises the principles of quantum mechanics to manipulate and harness quantum states for various purposes.

These technologies often exploit phenomena such as superposition and entanglement to enable new capabilities in computing, communication, sensing, cryptography and more.

The concept of "quantum" is central to the field of quantum mechanics, which is the branch of physics that describes the behaviour of particles at the atomic and subatomic levels. Quantum theory revolutionised our understanding of nature by introducing new principles and concepts that differ from classical physics.

STATE OF THE ART

Quantum computing

Quantum computers, with their ability to process information using qubits, are being developed by companies like IBM, Google and Microsoft and startups like Rigetti and IonQ. While still in its early stages, quantum computing shows promise as a disruptive technology for solving certain problems that would be impossible for even the largest current supercomputers or would take hundreds of years to tackle.

Currently, notable progress has been made in:

- Increasing the number of qubits.
- Correcting errors.

Quantum communication

Quantum communication ensures the secure transmission of information using quantum key distribution (QKD) protocols. Quantum encryption techniques based on entanglement allow for secure communication channels that are resistant to eavesdropping and hacking.

Key developments include:

- **Quantum key distribution (QKD):** QKD protocols enable the secure distribution of encryption keys using the principles of quantum mechanics, ensuring that information remains private and tamperproof.
- **Satellite-based quantum communication:** Researchers have successfully demonstrated long-distance quantum communication using satellites, enabling secure communication over large distances.

Quantum sensing

Quantum sensors utilise quantum properties to achieve high precision and sensitivity.

For example:

- **Atomic clocks** provide highly accurate timing used in navigation systems, telecommunications and scientific research.
- **Magnetometers** measure magnetic fields with high sensitivity, allowing applications in areas such as geological studies and medical diagnostics.

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QUANTUM CONCEPTS I

Quantum as a discrete unit

In quantum mechanics, the term "quantum" refers to the smallest and indivisible discrete unit of a physical property.

It is the fundamental unit of measurement in the quantum world, called "quanta". It's like having a box that can only be filled with specific elements, and you cannot have anything smaller than these elements.

Duality of the particle-wave

One of the most intriguing aspects of quantum mechanics is the duality of the particle-wave, which states that particles can exhibit properties similar to both waves and particles.

This means that entities like electrons and photons can behave like particles in some experiments and like waves in others, depending on the context of the experiment.

Superposition

Another fundamental concept is superposition, which states that quantum systems can exist in multiple states simultaneously.

Unlike classical objects, which have well-defined properties, quantum systems can be in a combination or superposition of different states.

For example, an electron can exist in a superposition of spin-up and spin-down states simultaneously.

QUANTUM CONCEPTS II

Qubits

In classical computing, the basic unit of information is called a "bit," which can represent either a 0 or a 1. In contrast, in quantum computing, the basic unit of information is called a "qubit," which can represent both 0 and 1 simultaneously due to the so-called superposition.

Qubits can be physically implemented using quantum systems such as trapped ions, superconducting circuits or photons. These systems allow for the manipulation and measurement of the quantum states of particles, enabling the representation and processing of qubits in a quantum computer.

Superconducting qubits

Superconducting qubits are a type of qubit that has been implemented using superconducting circuits.

Superconductivity is a phenomenon in which certain materials, when cooled to very low temperatures, can conduct electric current with zero resistance.

Superconducting qubits exploit the quantum properties of superconducting circuits to encode and process quantum information.

They are a crucial candidate for building large-scale quantum computers due to their scalability and compatibility with existing semiconductor technology.

Diamond

Diamond has gained attention in the field of quantum technologies due to its unique properties. Specifically, certain defects in diamonds, such as nitrogen vacancy (NV) centres, can be used as qubits.

NV centres are point defects in the diamond lattice that exhibit long coherence times and can be manipulated using light and microwaves. Qubits based on diamonds hold promise for applications in quantum sensing, quantum communication and quantum information processing.

QUANTUM CONCEPTS III

Entanglement

Entanglement is a phenomenon where two or more quantum systems become correlated in such a way that the state of one system cannot be described independently of the others. Entangled particles, even if separated by large distances, remain connected, and the state of one particle can instantaneously affect the state of the other, challenging classical notions of locality.

The EPR (Einstein, Podolsky and Rosen) thought experiment helps illustrate the phenomenon of entanglement. They proposed a scenario where two entangled particles are created and then separated by a great distance. In this experiment, if we measure a property of one particle, we instantaneously determine the property of the other.

Uncertainty principle

The uncertainty principle formulated by Werner Heisenberg states that there are inherent limits to the simultaneous knowledge of certain pairs of physical properties, such as the position and momentum of a particle, with absolute precision.

This principle highlights the fundamental indeterminacy and probabilistic nature of the quantum world. The more precisely we try to measure one property, the less precisely we can know the other.

QUANTUM CONCEPTS IV

Quantum interference

Quantum interference refers to the phenomenon in which quantum waves can interfere constructively or destructively. This interference pattern is observed when waves (e.g., electron waves) interact with each other, resulting in regions with enhanced probabilities (constructive interference) or diminished probabilities (destructive interference) for detecting particles. Interference plays a crucial role in various quantum phenomena and experiments.

Ion trap

An ion trap is a device that uses electromagnetic fields to capture and confine charged particles, typically ions.

In the context of quantum technologies, ion traps are used to trap and manipulate individual ions as qubits (quantum bits), which are the fundamental units of information in a quantum computer. Ion trap systems have been a key platform for building quantum computers with a high degree of control and long coherence times.

EPR generator

Scientists have created setups called EPR generators to generate entangled particles such as photons or ions.

These generators allow researchers to study and harness the power of entanglement for various applications, such as quantum communication and quantum computing.

03

RESEARCH & INNOVATION

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R&D

Through research groups distributed across its schools, the UPC has facilities and resources to provide services in the fields of diagnosis, consulting, development, demonstration, training, promotion and support to industry, the public sector and civil society in the advancement and deployment of quantum technologies.

UPC RESEARCH GROUPS IN QUANTUM TECHNOLOGIES

9 RESEARCH GROUPS

Groups with activity in quantum technologies:

- CBA – Communications and Broadband Architechtures Lab
- GAPCOMB - Geometric, Algebraic and Probabilistic Combinatorics
- GCO - Optical Communications Group
- SPCOM - Signal Processing and Communications
- CCQM - Condensed, Complex and Quantum Matter Group
- LOGPROG - Logic and Programming
- ISG-MAK - Information Security Group - Mathematics Applied to Cryptography

Groups with an emerging interest:

- GNOM - Group of Numerical Optimization and Modelling
- CNDS - Computer Networks and Distributed Systems
- MNT-Solar - Micro and Nanotechnologies Group for Solar Energy

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UPC RESEARCH CENTRES IN QUANTUM TECHNOLOGIES

2 RESEARCH CENTRES

IDEAI - Intelligent Data Science and Artificial Intelligence Research Group

Research centre based on the fields of AI and intelligent data science: machine learning algorithms, data science and data engineering, natural language processing systems, intelligent decision support systems, cognitive and computational reasoning systems, computer vision systems and technologies enabling information extraction from voice data.

CCABA - Advanced Broadband Communications Centre

CCABA is the reference centre for 5G communications systems at the UPC. Research activities were launched in January 1994 with the aim of integrating various UPC research groups in the field of broadband communications. All the related technologies associated with transmission, cable networks, optical fibre, radio support, switching and interconnection, telecommunications network management, protocols and services are the fields of interest of the CCABA.

COLLABORATORS

Companies

Research centres/institutes and universities

Examples of Activity I

Development of advanced signal coding and processing techniques for wireless communication networks.

Building **advanced signal processing schemes** for wireless communication networks with multiple antennas, using algorithms for matrix completion and advanced sampling techniques, among others.

Investigating **machine learning methods and signal processing tools in graphs** for the analysis and operation of wireless communication networks and other networks.

Improving the transmission of quantum bits at short distances through the development of **continuous quantum key distribution (QKD)** systems using coherent light states.

Investigating the fundamental limits of secure communications using quantum devices and designing **new channel codes for classical-quantum channels** that model the noisy behaviour of quantum computers.

Use of quantum gas as a refrigerant for quantum technology development.

Studying the interaction between **quantum liquids and solids** to investigate **aqueous systems, bio-membranes and polymers.**

Examples of Activity II

Improvement of network management and performance beyond 5G using artificial intelligence (AI) and machine learning (ML) techniques.

Experimental evaluation of **signal coding and processing techniques** through field tests or the use of experimental quantum computers.

Development of innovative optical network solutions for mobile networks beyond **5G and 6G.**

Design of algorithms capable of resisting threats and preserving information confidentiality using biometric recognition.

Development of quantum simulators to address complex societal problems such as drug design.

Development of technology and architecture for future **quantum repeaters**, enabling quantum communications over much greater distances than current capabilities.

Use of **quantum key distribution (QKD)** for secure communications.

04

UPC PROJECTS OF EXCELLENCE

In this document, projects are considered projects of excellence because:

- The scientific process is rigorous and complies with high-quality standards.
- They are strategic and driving forces.
- They commit to social challenges and have a significant scientific and socioeconomic impact.
- They have a territorial impact.
- They involve different entities in the quadruple helix, making the projects multidisciplinary.

UPC projects of excellence are funded by various programmes, such as the State Plan and Horizon Europe.

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UPC PROJECTS OF EXCELLENCE

QUANTUM CAT - Quantum Technologies Hub of Catalonia

QUANTUM CAT is an alliance to promote emerging entities in quantum technologies in Catalonia.

Quantum technologies make use of the exceptional properties of quantum physics (the theory that defines the behaviour of matter at the subatomic scale) with the aim of providing unprecedented capabilities in today's information society.

These technologies have evolved from mere theoretical possibilities to real solutions applied in emerging fields such as internet security and non-invasive brain monitoring.

The action is divided into four projects:

- **Quantum communication**
- **Quantum computing**
- **Quantum simulation**
- **Quantum sensors**

UPC research groups involved: SPCOM, CCQM

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ALLEGRO - Agile uLtra Low EnerGy secuRe netwOrks

The **ALLEGRO** project, funded by the EU, aims to develop an innovative optical network solution for mobile networks beyond 5G and 6G. This innovative solution will significantly increase transmission capacities, reduce energy consumption costs and enhance data security. It will leverage transparent and energy-efficient integrated photonic optical switches, advanced data security measures, innovative transceivers, multiband and multifibre technologies and an artificial intelligence-based management system to improve network performance.

The ALLEGRO project is poised to revolutionise optical networks and pave the way for future advancements in mobile network technology.

UPC research group involved: GCO

COTTON - Biometric cryptosystems for post-quantum technologies

The project aims to propose a biometric cryptosystem that is resistant to quantum technologies.

The cryptosystem's robustness relies on the use of cryptographic algorithms that, when the system is correctly configured with specific parameters (key length, error-correcting capability, etc.), are resistant to all known quantum attacks to date. This would allow for the use of both public-key cryptography, generally used for session key establishment, and private-key cryptography for transmitting confidential information.

The cryptosystem has another interesting property: it uses biometric recognition, along with the public-key algorithm, to verify the security and identity of the user requesting access to a specific electronic banking application.

UPC research groups involved: Department of Electronic Engineering

UPC PROJECTS OF EXCELLENCE

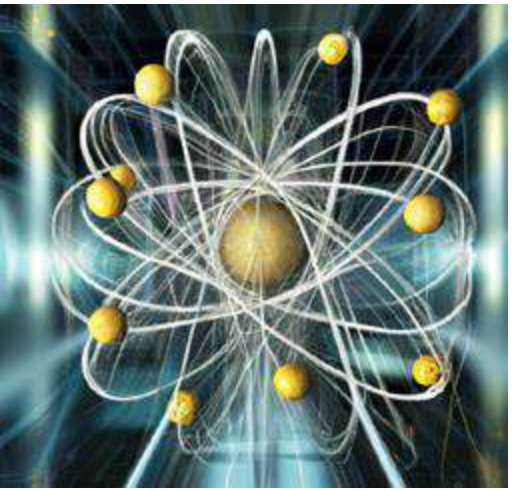
MADDIE – Communication, coding and processing technologies for next-generation quantum networks

The MADDIE project leads the development of 6G networks, fusing classical and quantum technologies for future advanced applications. With a focus on coding, communication and signal processing, it addresses challenges such as security and efficiency in hybrid networks. MADDIE seeks innovative solutions for the low latency and high capacity demands of the networks of the future.

Through research into wireless technologies and distributed processing methods, MADDIE promotes an infrastructure ready for the coexistence of multiple applications. Aiming to improve security and computational efficiency, the project becomes a key player in shaping the next era of global connectivity.

UPC research groups involved: Department of Signal Theory and Communications

UPC PROJECTS OF EXCELLENCE



QUADRATURE - Scalable multi-chip quantum architectures enabled by cryogenic wireless / quantum-coherent network-in-package

The objective of the QUADRATURE project is to develop scalable quantum computing architectures capable of addressing real-world problems. This will be achieved by creating interconnected distributed quantum cores through coherent quantum-qubit state transfer links and integrated wireless interconnections.

The project aims to experimentally test the feasibility of qubit state transfer links and wireless links in packets, develop protocols for an integrated coherent quantum network and implement scalable architectural methods.

The ultimate goal is to demonstrate significant performance improvements, at least 10 times better, through spatial optimisation of multi-scale design and benchmarking with quantum algorithms.

UPC research groups involved: IDEAI-UPC

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UPC PROJECTS OF EXCELLENCE

SOQUGAL - Quantitative study of quantum gases, liquids and solids at low temperatures. Simulation of quantum ultradilute gases and liquids

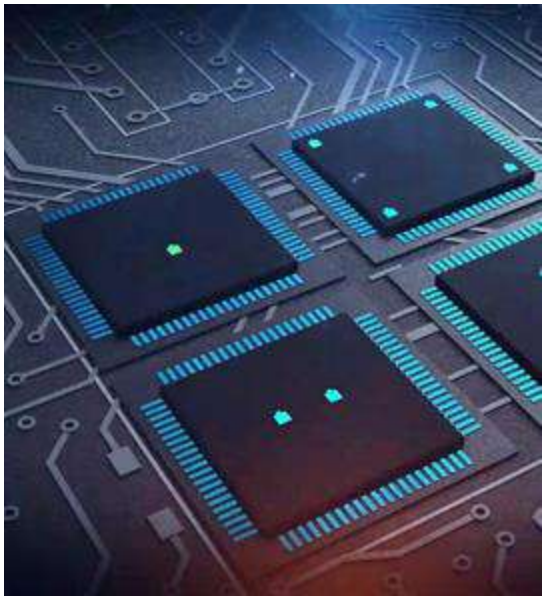
The main goal of the coordinated project is to carry out quantum Monte Carlo (QMC) simulations of ultracold quantum matter in the strongly and weakly interacting regimes.

It has previously been obtained what is probably the most precise description of the properties of ultradilute droplets at zero temperature. In SOQUGAL project, it is planned to go further and develop numerical and analytical techniques to address finite-temperature and dynamical properties of liquids, single-component gases and multi-component mixtures.

We also plan to continue our study of helium on graphite and to study ultracold Fermi systems showing SU(N) symmetry. A novel line of investigation is the use of density functional theory (DFT) in order to improve the degree of predictability of QMC studies for excitons in transition metal dichalcogenide (TMD) materials, another field that is rapidly expanding. To achieving this aim, advanced DFT techniques will be employed in combination with the input from the state-of-the-art diffusion Monte Carlo simulations.

UPC research groups involved: CCQM

WINC - Wireless Networks within Next-Generation Computing Systems



The WINC project envisions a revolution in computer architecture enabled by the integration of wireless networks into computing systems. The main hypothesis is that terahertz wireless technology will lead to at least a tenfold improvement in the speed, efficiency and scalability of both non-quantum and quantum systems.
With a comprehensive approach, WINC aims to validate the hypothesis by:

- Revealing the fundamental limits of wireless communications within computer packages,
- Developing antennas and protocols that operate close to these limits while meeting strict scenario constraints, and
- Developing radically new architectures that translate the unique benefits of wireless vision into orders of magnitude improvements at the system level.

If successful, WINC will be the seed of a new generation of quantum and non-quantum systems and will foster progress in the field of computing over the coming decades.

ERC Starting Grant (Sergi Abadal Cavalle)
UPC research group involved: CBA

UPC PROJECTS OF EXCELLENCE

TRAINER - Research in future fully optimized networks through artificial intelligence

The TRAINER-A project aims to improve the management and performance of networks beyond 5G using artificial intelligence (AI) and machine learning (ML) techniques. It will investigate the creation of an innovative network knowledge plane using deep learning techniques, such as graph neural networks (GNN), to orchestrate and automatically provision network services considering their specific requirements.

The project will also explore monitoring techniques to obtain information about user/device behaviour, perceived quality of experience (QoE) and observed network metrics in network service providers (NSPs).

UPC research groups involved: Department of Computer Architecture

ARTICLES

Kartashov, Y.V. [et al.]. Frontiers in Multidimensional Self-Trapping of Nonlinear Fields and Matter. "Nature Reviews Physics", 22 February 2019, vol. 1, p. 185-197. http://hdl.handle.net/2117/343553
The article explores the challenge of stabilising multidimensional solitary states such as solitons and quantum droplets in different physical systems.

Meier, E., An, F., Dauphin, A., Maffei, M., Massignan, P., Hughes, T., Gadway, B. Observation of the topological Anderson insulator in disordered atomic wires. "Science", 23 November 2018, vol. 362, no. 6417, p. 929-933. http://hdl.handle.net/2117/127477
The article investigates the interplay between topology, disorder and quantum transport in one-dimensional chiral wires. Controllable disorder induces transitions from topologically trivial to non-trivial phases, with implications for strongly interacting topological fluids.

Bötcher, F. [et al.]. Dilute dipolar quantum droplets beyond the extended Gross-Pitaevskii equation. "Physical review research", 8 November 2019, vol. 1, no. 3, p. 033088:1-033088:12. http://hdl.handle.net/2117/191091
The study examines the critical atom number, revealing discrepancies between experimental results and theoretical predictions. This challenges the current understanding of quantum droplets and emphasises the importance of correlations in the system. The research suggests the system's potential to test many-body theories.

Massignan, P. [et al.]. Two-dimensional topological quantum walks in the momentum space of structured light. "Optica", 20 February 2020, vol. 7, p. 108. http://hdl.handle.net/2117/335321
The article presents a new approach to simulate two-dimensional quantum walks using photons. By encoding walker positions in the transverse components of the light beam's wave vector and applying polarisation-dependent transverse "kicks," the desired dynamics and topological features can be achieved.

Main articles

ARTICLES

Other articles

Ball, S. ; Centelles, A. ; Huber, F. “Quantum error-correcting codes and their geometries”. *Annales de l'Institut Henri Poincaré D*, 10 February 2023, vol. 10, no. 2, p. 337-405. https://futur.upc.edu/36635301

Ganguly, A. [et al.]. Interconnects for DNA, quantum, in-memory and optical computing: insights from a panel discussion. "IEEE micro", May-June 2022, vol. 42, no. 3, p. 40-49. http://hdl.handle.net/2117/367524

Salek, F. [et al.]. One-shot capacity bounds on the simultaneous transmission of classical and quantum information. "IEEE transactions on information theory", 7 October 2019. http://hdl.handle.net/2117/169376

Álvarez, J. [et al.]. Random number generation by coherent detection of quantum phase noise. "Optics express", 17 February 2020, vol. 28, no. 4, p. 5538. http://hdl.handle.net/2117/179831

Rodrigo, S. [et al.]. On double full-stack communications-enabled architectures for multi-core quantum computers. "IEEE micro", September 2021, vol. 41, no. 5, p. 48-56. http://hdl.handle.net/2117/349287

Ahmadian, S. [et al.]. Cost-effective ML-powered polarization-encoded quantum key distribution. "Journal of lightwave technology", 1 July 2022, vol. 40, no. 13, p. 4119-4128. http://hdl.handle.net/2117/380010

Iqbal, M. [et al.]. LPsec: a fast and secure cryptographic system for optical connections. "Journal of optical communications and networking", April 2022, vol. 14, no. 4, p. 278-288. http://hdl.handle.net/2117/368179

ARTICLES

Other articles

Blasco, A.; R. Fonollosa, J. Perfect and quasi-perfect codes for the Bosonic classical-quantum channel. "IEEE transactions on quantum engineering", 18 January 2023, vol. 4, article 2100208. http://hdl.handle.net/2117/384530

Blasco, A.; Vázquez, G.; R. Fonollosa, J. Generalized perfect codes for symmetric classical-quantum channels. "IEEE transactions on information theory", September 2022, vol. 68, no. 9, p. 5923-5936. http://hdl.handle.net/2117/373658

Perez, J.; Pagès-Zamora, A.; R. Fonollosa, J. Quantum multiple hypothesis testing based on a sequential discarding scheme. "IEEE access", 14 January 2022, vol. 10, p. 13813-13826. http://hdl.handle.net/2117/364859

Salek, F.; Hsieh, M.; Fonollosa, J. R. Single-serving quantum broadcast channel with common, individualized, and confidential messages. "IEEE transactions on information theory", December 2020, vol. 66, no. 12, p. 7752-7771. http://hdl.handle.net/2117/336701

DOCTORAL THESES

From hypothesis testing of quantum channels to secret sharing (link)

This thesis addresses three main aspects of quantum information theory. In the first part, hypothesis testing for quantum channels is investigated, obtaining results on adaptive and non-adaptive strategies. In the second part, new protocols are developed to convert noisy quantum correlations into classical or noise-free correlations. In the third part, communication through quantum channels in the presence of third parties is studied.

Ultracold Bose and Fermi dipolar gases: a quantum Monte Carlo study (link)

Study of dipolar systems in the quantum degenerate regime using Monte Carlo methods. Various techniques such as variational Monte Carlo, diffusion Monte Carlo, path integral Monte Carlo and path integral ground state are employed to obtain numerical solutions and characterise properties such as superfluidity and dipolar droplet formation.

Ab-initio quantum Monte Carlo study of ultracold atomic mixtures (link)

Study of the properties of mixtures of Bose-Einstein condensates at low temperatures. Quantum Monte Carlo methods and density functional theory are used to understand the physics beyond the mean-field theory in these mixtures. Aspects such as energy, saturation density, surface tension and excitation modes are investigated in different configurations. Additionally, the phase diagram of bosonic mixtures in a spherical harmonic trap is analysed.

Correlations in spin-orbit coupled ultracold quantum gases (link)

Calculating properties of quantum many-body systems with spin-orbit coupling interactions. Quantum Monte Carlo methods are used to study systems with spin-orbit coupling, and different phases are analysed. The impact of correlations is investigated, and results that differ from mean-field theory are found. Systems with angular spin-orbit coupling are also explored.

PAST AND FUTURE DOCTORAL THESES

Title: Artificial intelligence solutions for quantum communications
Author: Seyed Morteza Ahmadian
Date of defence: 2023

Title: Quasi-Perfect Codes for the Classical-Quantum Channel
Author: Andreu Blasco
Date of defence: 2023

Title: A double full-stack architecture for multi-core quantum computers
Author: Santiago Rodrigo
Date of defence: 2023

Title: Designing Communication Networks for Large-scale Modular Quantum Computer Architectures
Author: Sahar Ben Rached
Date of defence: 2025

Title: Towards Scalable Multi-Core Quantum Architectures through Network-Architecture-Compiler Co-Design
Author: Pau Escofet
Date of defence: 2026

05

EDUCATION

Degree in Physics Engineering

The first of its kind in the whole of Spain, and accredited with the Seal of Excellence by the Agency for the Quality of the University System (AQU) of Catalonia, it is aimed at students with very good aptitudes in physics and mathematics who want to apply the principles of basic science to technological problems in a multidisciplinary environment, and who accept the challenge of inventing the technology of the future and working on research that will transform the world.

Master's degree in Cybersecurity

The aim of the master's degree in cyber security is to offer the student a solid scientific basis in the field of information technology security with the aim of providing society with highly specialized professionals in data protection, data protection infrastructure and application protection.

Master's degree in Quantum Science and Technology

Coordinated by the University of Barcelona (UB) with the participation of the UPC, this master's degree provides students with advanced knowledge and equips them to carry out cutting-edge theoretical and experimental research in quantum simulation, quantum computing, quantum sensors and quantum communications, as well as purely theoretical research.

Master's degree in Physics Engineering

This master's degree offers advanced training in physics in various areas, such as advanced statistics, quantum physics, physics and engineering of large facilities, among others.

Master’s degree in Photonics

The aim of the master's degree is to provide students with a broad and solid foundation in different areas of photonics, as well as the necessary tools to enable them to become future researchers or entrepreneurs in this field. The most important institutions that carry out research in photonics in the Barcelona area (Universitat Politècnica de Catalunya, UPC; Universitat Autònoma de Barcelona, UAB; Universitat de Barcelona, UB, and Institute of Photonic Sciences, ICFO) participate in this program.

Master’s degree in Telecommunications Engineering

This master's degree offers a broad profile that includes skills and knowledge in communications systems, networks, electronics and audiovisual systems in order to acquire the professional skills required to practice the profession of telecommunications engineering.

Master’s degree in Advanced Telecommunication Technologies

Designing, managing and executing projects in the field of telecommunications engineering are some of the key skills offered by this master's degree. Some of the projects are related to:

- Artificial intelligence systems based on structured data and unstructured data.
- Security in communication networks: cryptography, user authentication, digital signatures.
- Electronic circuits and components: microprocessors, devices (routers, switches, etc.), sensors, actuators, transducers.
- Radio, fiber optic and copper communications systems.

Postgraduate degree in Quantum Engineering at UPC School

The Postgraduate Degree in Quantum Engineering aims to provide a comprehensive education in quantum technologies and is aimed at professionals in engineering, mathematics, physics, computing or information and communication technologies (ICT) who have interest in this rapidly evolving field of technology that heralds disruptive change. With the skills acquired in the program, these new profiles will be able to implement and develop projects based on quantum technologies.

UPC Doctoral School

The UPC Doctoral School offers several doctoral programs that address the study of quantum technologies.

Catalonia Quantum Academy

Collaborative platform under Quantica Mediterranean Valley of Quantum Science and Technologies, established to coordinate efforts to leverage the region's internationally recognized expertise to strengthen education, training and professional development in Quantum Science and Technology (QST).

RESEARCH AND INNOVATION SUPPORT SERVICE

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