AM08

Quantum Information and Computation

Información y Computación Cuántica

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Description **Descripción** **Deskribapena**

Quantum mechanics has been a catalyst for new advances in many areas of mathematics, from the theory of Hilbert spaces and operators to category theory. At the dawn of quantum technologies, understanding quantum phenomena and their potential applications in faster computing or more secure information transmission, is highly relevant.
Quantum information has emerged at the interplay of math, physics and computer science for classifying simple and complex states and algorithms. Here, we will discuss recent progress in quantum information and computation, with a focus on the necessary mathematical tools to derive relevant applications such as efficient learning algorithms to extract information about the behavior of quantum systems.

La mecánica cuántica ha sido catalizador de nuevos avances en muchas áreas de las matemáticas, desde la teoría de los espacios de Hilbert hasta la teoría de categorías. En los albores de las tecnologías cuánticas, la comprensión de los fenómenos cuánticos y sus posibles aplicaciones en una computación más rápida o una transmisión de información más segura es de gran relevancia.
La información cuántica ha surgido en la interacción de las matemáticas, la física y la informática para clasificar estados y algoritmos simples y complejos. Analizaremos los avances recientes, centrándonos en las herramientas necesarias en aplicaciones relevantes como algoritmos de aprendizaje eficientes para estudiar comportamiento de los sistemas cuánticos.

MSC Codes | **Códigos MSC** | **MSC Kodeak**

81Qxx
(primary)

81P68; 81P73; 68Q12; 81S22
(secondary)

Slots | **Bloques** | **Blokeak**

2.B (Aula 0.12); 2.C (Aula 0.12)

QR Code | **Código QR** | **QR Kodea**

Session Schedule | **Horario de la Sesión** | **Saioaren Ordutegia**

J16 | 16:30-16:50 | 0.12
Hamiltonian simulation through the Magnus expansion: is it universal?
Emilio Onorati (Technical University of Munich)

J16 | 17:00-17:20 | 0.12
A cb-Bohnenblust-Hille inequality with constant one and its applications in Learning Theory
Francisco Escudero Gutiérrez (QuSoft & Centrum Wiskunde & Informatica Amsterdam)

J16 | 17:30-17:50 | 0.12
Local minima and barren plateaus in energy landscapes of spin glass Ising models
Pablo Páez Velasco (Universidad Complutense de Madrid)

J16 | 18:00-18:20 | 0.12
Learning finitely correlated states: stability of the spectral reconstruction
Marco Fanizza (University of Copenhagen)

V17 | 9:00-9:20 | 0.12
Quantum Fisher Information and its dynamical nature
Matteo Scandi (Instituto de Física Teórica)

V17 | 9:30-9:50 | 0.12
Undecidability of the spectral gap in symmetric Hamiltonians
Laura Castilla Castellano (Universidad Complutense de Madrid)

V17 | 10:00-10:20 | 0.12
Beyond the Contraction Coefficient: Understanding the Average Contraction of Quantum Channels
Rubén Ibarrondo (UPV/EHU)

V17 | 10:30-10:50 | 0.12
A generic quantum Wielandt's inequality in matrix algebra and Lie algebra
Yifan Jia (University of Copenhagen)

Thursday 16	**Jueves 16**	**Osteguna 16**
16:30-16:50	**16:30-16:50**	**16:30-16:50**
[Room 0.12]	**[Aula 0.12]**	**[Gela 0.12]**

Hamiltonian simulation through the Magnus expansion: is it universal?

Emilio Onorati
(Technical University of Munich)

Hamiltonian simulation is considered a powerful instrument in quantum science as well as a precious tool for philosophical inquiry of reality: given a set of Hamiltonians, can we use them to reproduce properties of other systems that we cannot directly access? We will explore the possibility of simulating other quantum systems when we can manipulate only Hamiltonians that vary over time under physically-motivated constraints. The answer will be determined by the corresponding Magnus expansion.

Thursday 16	**Jueves 16**	**Osteguna 16**
17:00-17:20	**17:00-17:20**	**17:00-17:20**
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A cb-Bohnenblust-Hille inequality with constant one and its applications in Learning Theory

Francisco Escudero Gutiérrez
(QuSoft & Centrum Wiskunde & Informatica Amsterdam)

We show that Bohnenblust-Hille inequality for m-homogeneous polynomials holds with constant one when the operator norm is replaced by the completely bounded norm. Moreover, we show that it finds some interesting consequences in quantum learning theory. Next, we broaden our investigation of the Bohnenblust-Hille inequality to other contexts, and we extend recent results by Volberg and Zhang, demonstrating its applicability within a framework we have termed 'Learning Low-Degree Quantum Objects'.

Thursday 16	**Jueves 16**	**Osteguna 16**
17:30-17:50	**17:30-17:50**	**17:30-17:50**
[Room 0.12]	**[Aula 0.12]**	**[Gela 0.12]**

Local minima and barren plateaus in energy landscapes of spin glass Ising models

Pablo Páez Velasco
(Universidad Complutense de Madrid)

One of the main obstacles in VQAs is the presence of barren plateaus (BP) and local minima in their energy landscape. We will study the problem of minimising the energy of a family of classical Ising models and prove that the problem is hard to solve. We compare this fact to some previous results obtained for the convergence of Langevin dynamics algorithms. From this, we conclude that our family of Ising models do not have local minima, so they must exhibit BP in their energy landscapes.

Thursday 16	**Jueves 16**	**Osteguna 16**
18:00-18:20	**18:00-18:20**	**18:00-18:20**
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Learning finitely correlated states: stability of the spectral reconstruction

Marco Fanizza
(University of Copenhagen)

Matrix product operators efficiently describe states on a 1D lattice. We consider the task of learning a realization from copies of an unknown state, measuring the error of the reconstructed operators in trace norm. We bound the error as a function of the system size and other relevant parameters, proving that the sample and computational complexity of the task are polynomial. We give refined bounds for states generated by quantum memories, and we extend the bounds to the non-translation invariant case.

Friday 17	**Viernes 17**	**Ostirala 17**
9:00-9:20	**9:00-9:20**	**9:00-9:20**
[Room 0.12]	**[Aula 0.12]**	**[Gela 0.12]**

Quantum Fisher Information and its dynamical nature

Matteo Scandi
(Instituto de Física Teórica)

Quantum Fisher Information is customarily used is metrology, where it is interpreted as a distinguishability measure between quantum states. In this talk we change the perspective, focussing on an aspect that was partly overlooked in the literature: its connection to quantum dynamics. Indeed, we prove that natural properties of evolutions can be formulated rather simply in terms of quantum Fisher information, showcasing its inherently dynamical nature.

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9:30-9:50	**9:30-9:50**	**9:30-9:50**
[Room 0.12]	**[Aula 0.12]**	**[Gela 0.12]**

Undecidability of the spectral gap in symmetric Hamiltonians

Laura Castilla Castellano
(Universidad Complutense de Madrid)

The problem of determining the existence of a spectral gap has previously been shown to be undecidable in systems of one or more dimensions. However, since symmetric behaviours can be found in most physical systems, we study if the problem is still undecidable even for 2-dimensional systems whose Hamiltonian presents rotational symmetry. Our result shows that even with this symmetry, the problem remains undecidable.

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Beyond the Contraction Coefficient: Understanding the Average Contraction of Quantum Channels

Rubén Ibarrondo
(UPV/EHU)

The contraction coefficient quantifies the noise introduced by a quantum channel. However, it is often overly optimistic and may not represent the behavior encountered in practical tasks. In this talk, we introduce the moments of contraction obtained from the distribution of the ratio between output and input state distinguishability, including the average contraction. We find a notable gap between the contraction coefficient and the average contraction for a set of product and LDP channels.

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A generic quantum Wielandt's inequality in matrix algebra and Lie algebra

Yifan Jia
(University of Copenhagen)

Quantum Wielandt's inequality provides an optimal upper bound on the minimal length k such that k-length products of elements in a generating set span the n-by-n matrix algebra. These bounds yield nice results for the primitivity index of quantum channels and injectivity index of PEPS. We show that k generically scales as $\Theta(\log n)$ and discuss a recent proof that k is $O(n^2)$ in general. We extend this to Lie algebras and explore its application to unitary generation in quantum computation.