

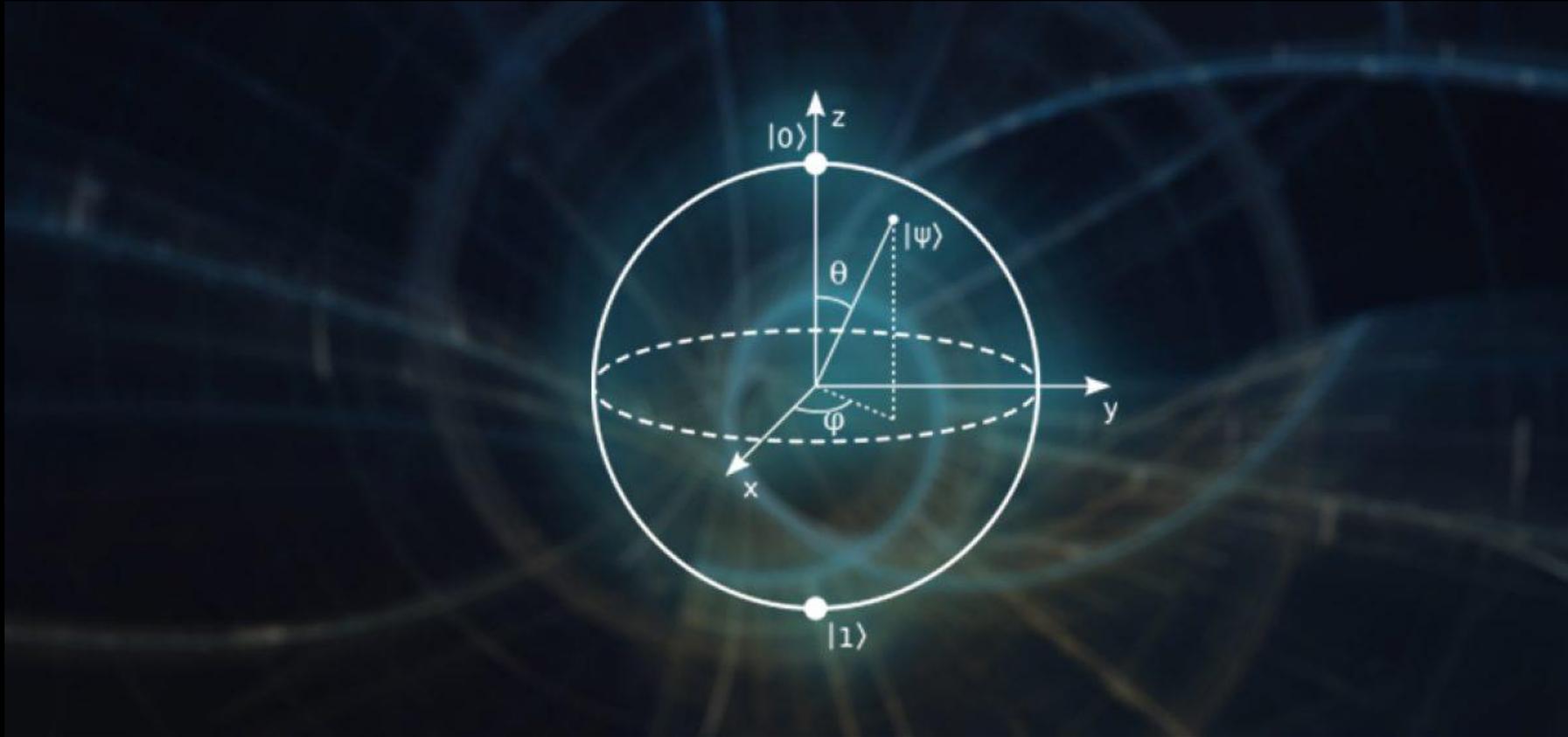


Seminario de Óptica Cuántica
**“Quantum Computing: How to Code in a
Quantum Processor?.”**

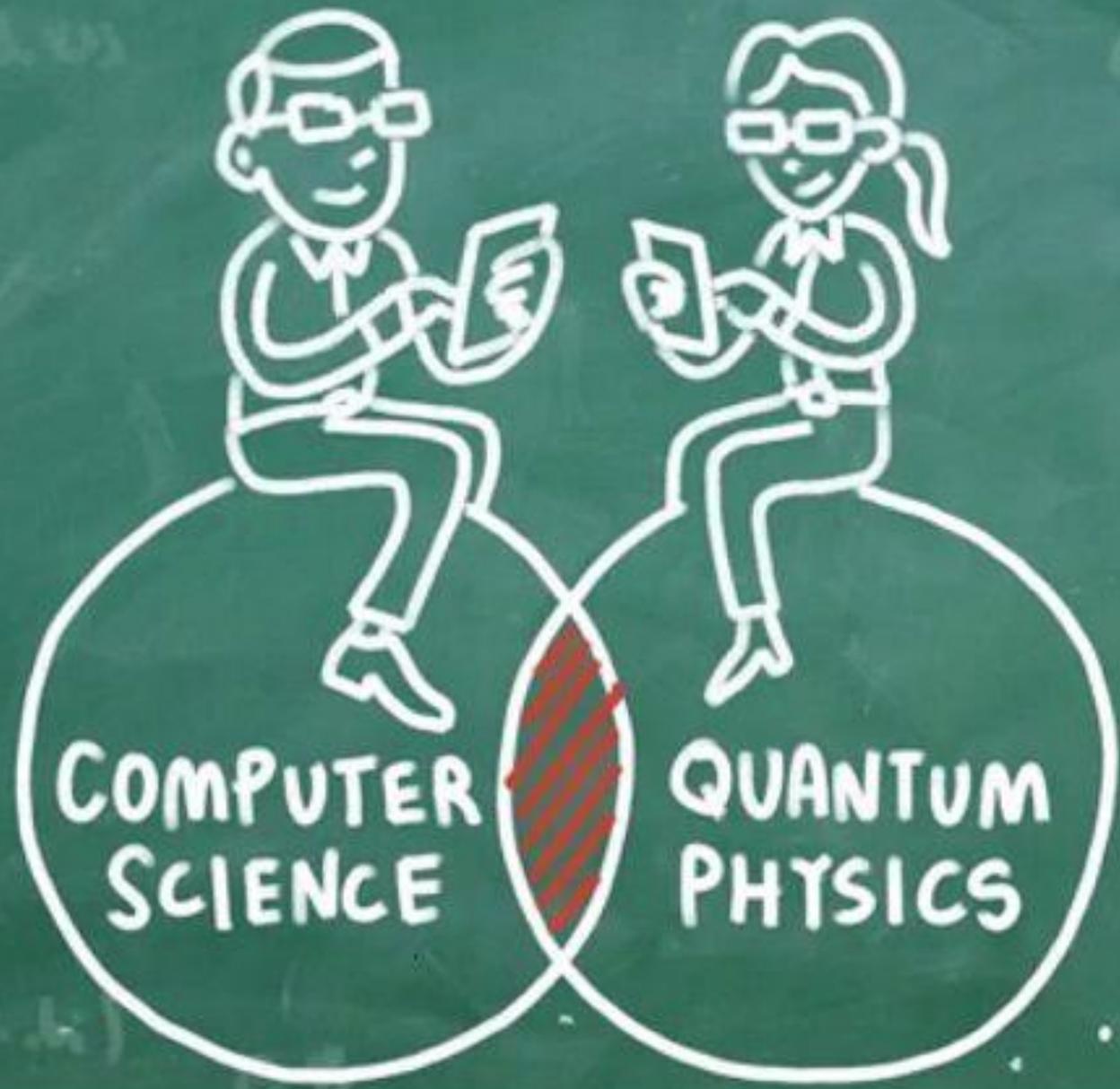
Mateo Laguna Guantiva
Universidad de los Andes

22 de marzo de 2018 - Bloque IP Sala-101 - 2:00 p.m. - Entrada libre

Computación Cuántica



¿Qué es?

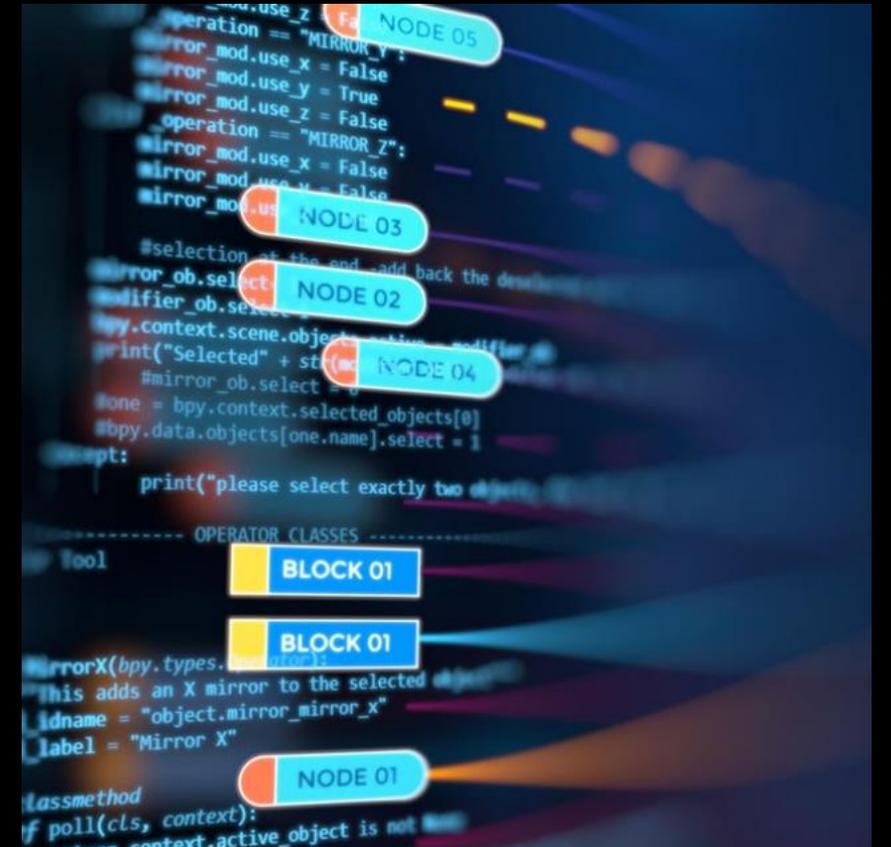
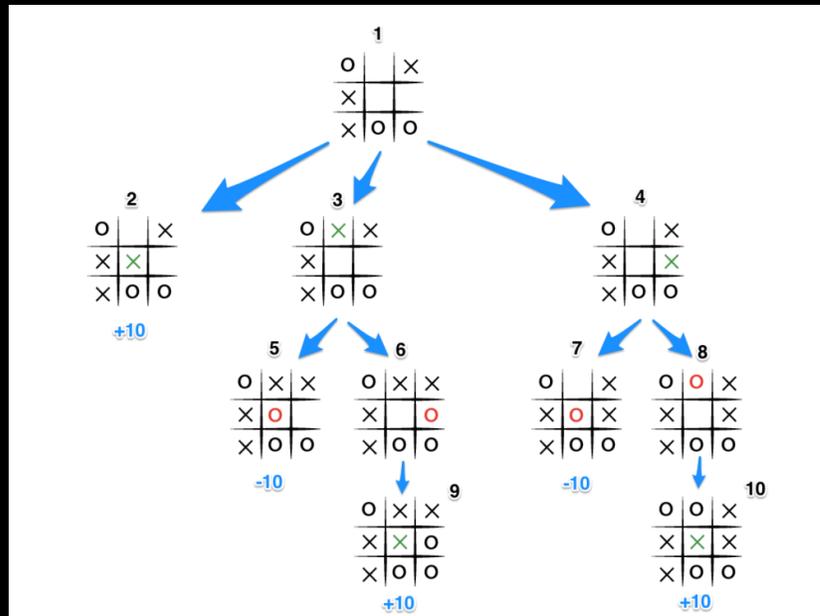


¿Qué es Computación Cuántica?

Computación

Información

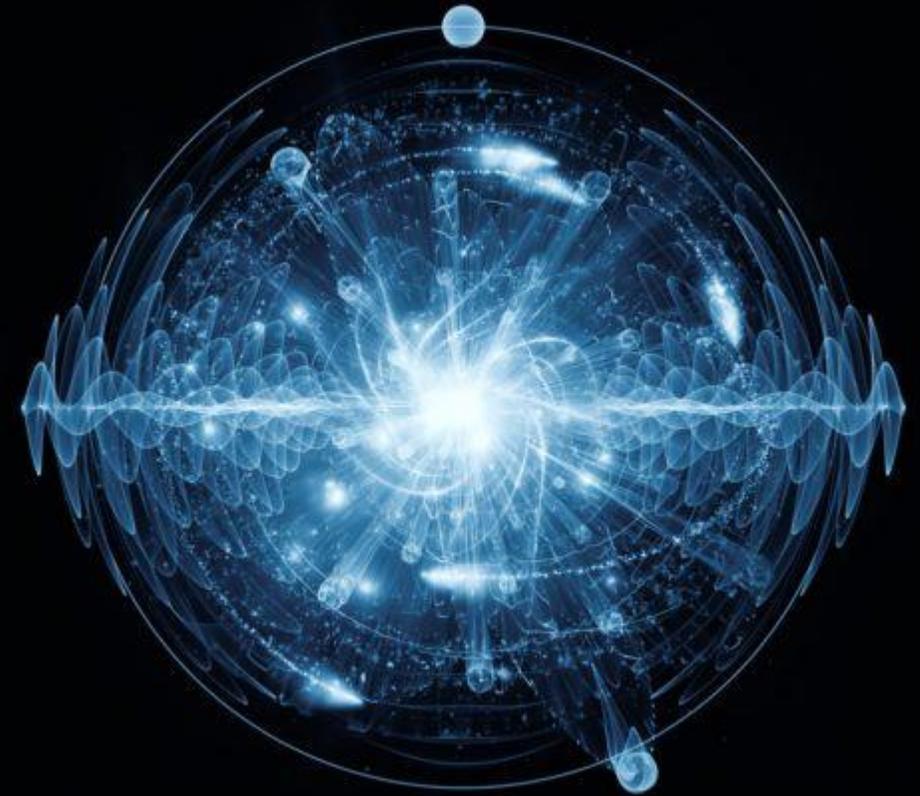
Algoritmos



Escalas más pequeñas del Universo

Mecánica Cuántica

Teoría física



$$\hat{H}|\psi(t)\rangle = i\hbar \frac{\partial}{\partial t} |\psi(t)\rangle$$

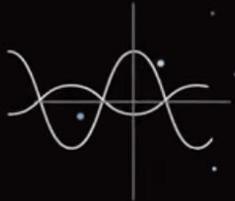
$$\frac{1}{c^2} \frac{\partial^2 \phi_n}{\partial t^2} - \nabla^2 \phi_n + \left(\frac{mc}{\hbar}\right)^2 \phi_n = 0$$



$$|0\rangle = (1, 0)$$

$$|1\rangle = (0, 1)$$

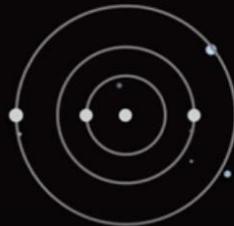
$$\frac{1}{\sqrt{2}}(|00\rangle + |11\rangle)$$



$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle,$$

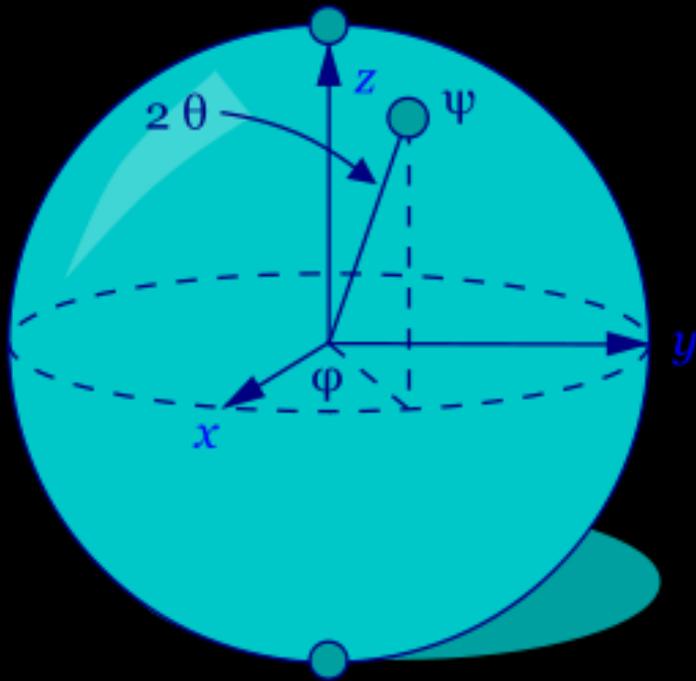
$$\alpha = e^{i\psi} \cos \frac{\theta}{2},$$

$$\beta = e^{i(\psi+\phi)} \sin \frac{\theta}{2}$$



Propiedades de la Mecánica Cuántica

Superposición



Entrelazamiento



¿Qué es la computación cuántica?

Quantum computation is the study of the information processing tasks that can be accomplished using quantum mechanical systems

¿Qué es la computación cuántica?

“Quantum computation is the study of the information processing tasks that can be accomplished using quantum mechanical systems”

¿Para qué sirve?

Criptografía y Seguridad





“Is the practice and study of techniques for secure communication in the presence of third parties called adversaries.”

Algoritmo RSA

$$13^*3=39 \quad 39/2=19.5$$

$$17^*7=119 \quad 119/2=59.5 \quad 119/3=39.66 \quad 119/5=23.8$$

$$2^{77'232.917} - 1$$

$$2^{74'207.281} - 1$$

Número con 23,249,425 de dígitos.

Número con 22,338,618 de dígitos.

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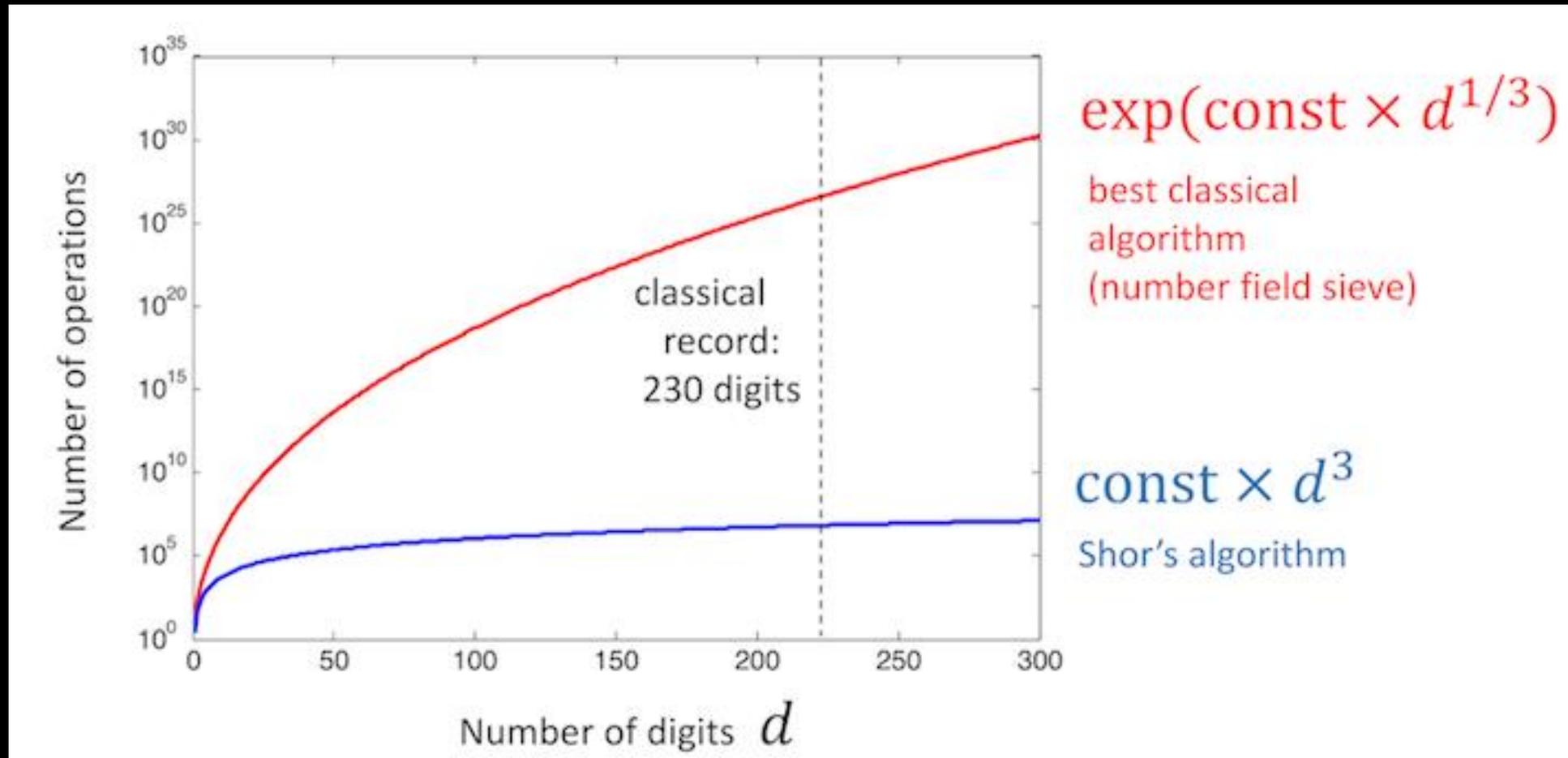
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Algoritmo RSA vs Algoritmo de Shor

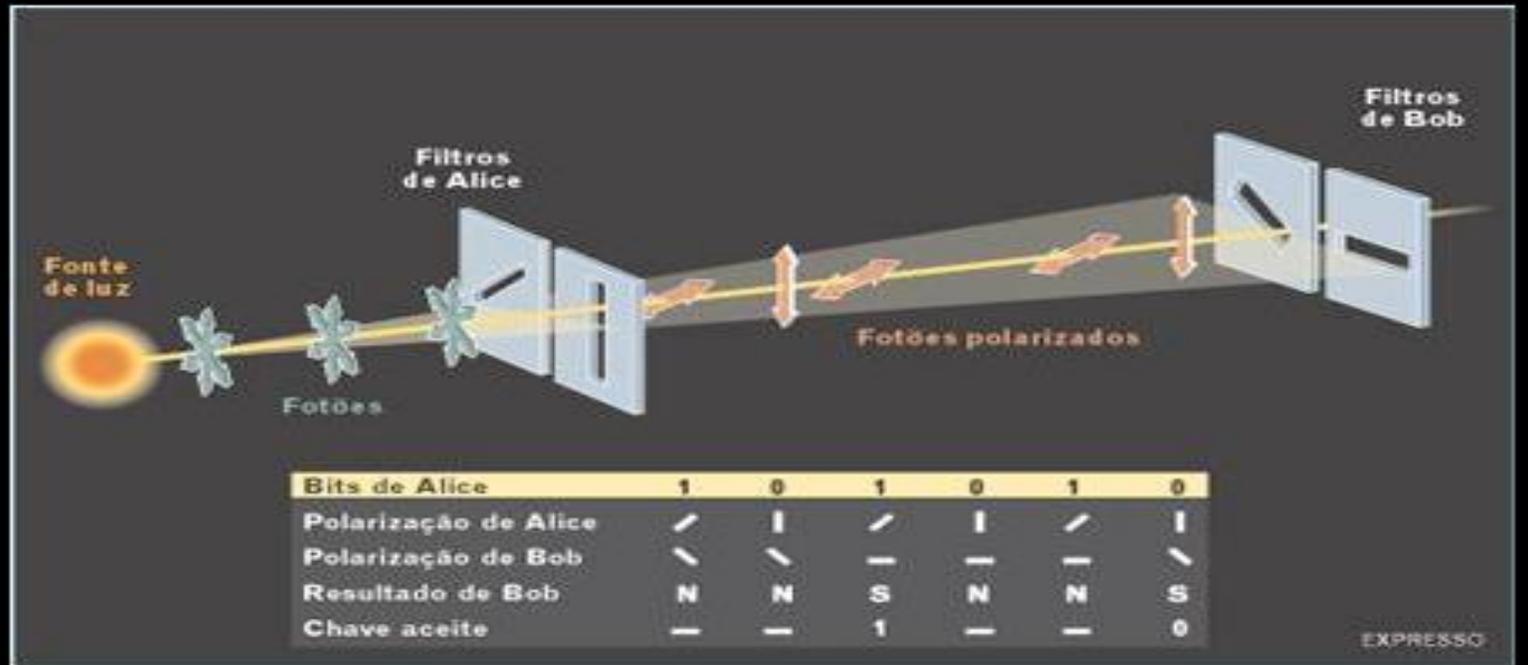


Factorizar primos y criptografía

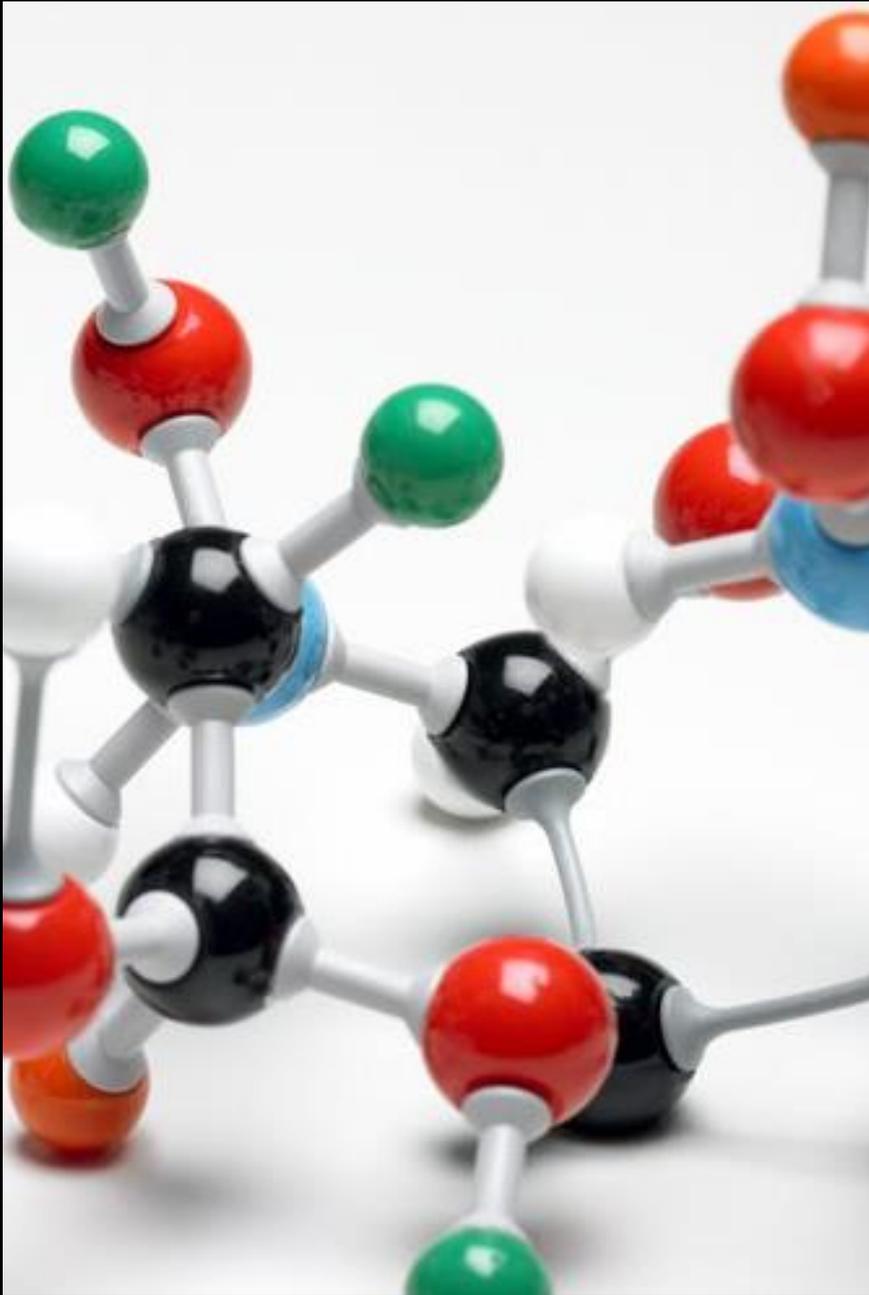
A working quantum computer could factor numbers in a day that would take a classical computer millions of years.

Factorizar primos y criptografía

A working quantum computer could factor numbers in a day that would take a classical computer millions of years.



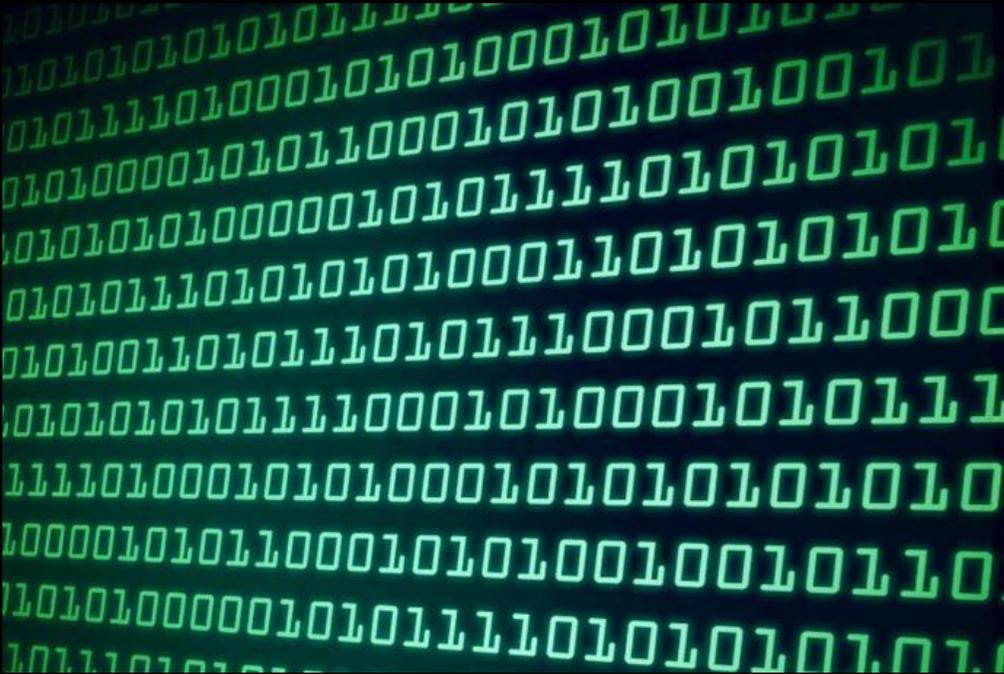
Medición y superposición



Revolución farmacéutica

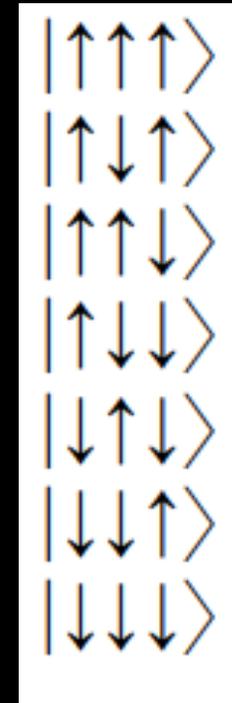
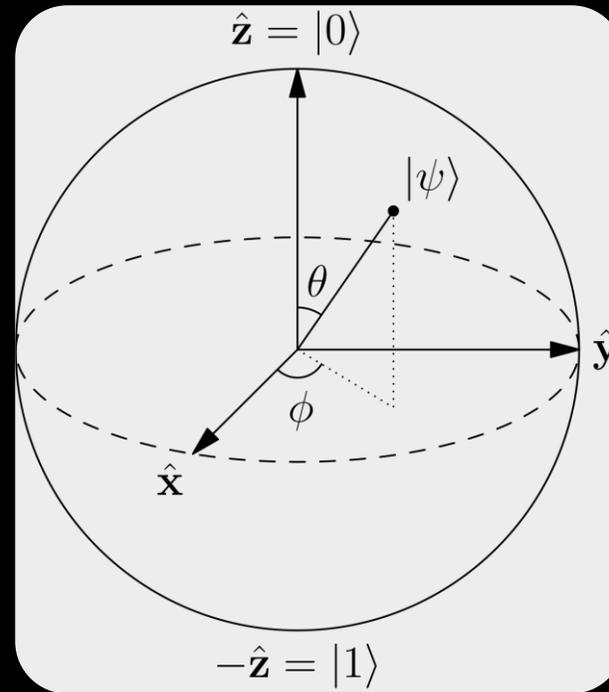
Algunos números

Clásico



3 bits

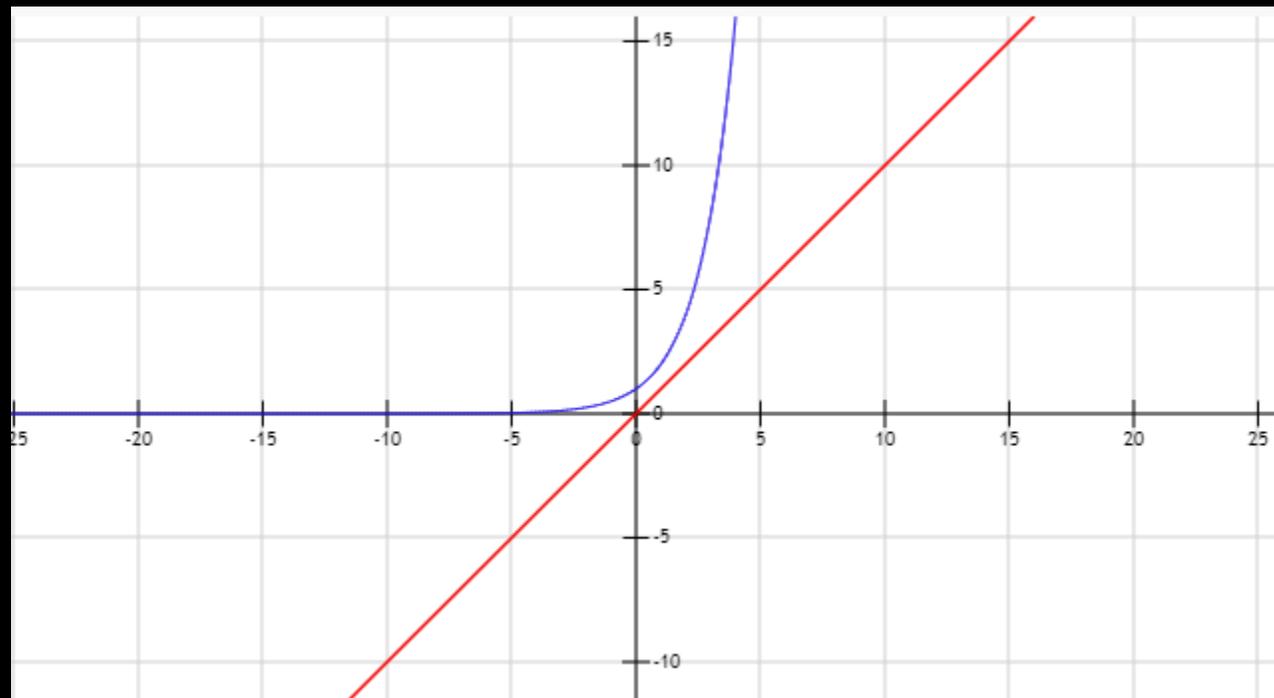
Cuántico



8 bits

N vs 2^N

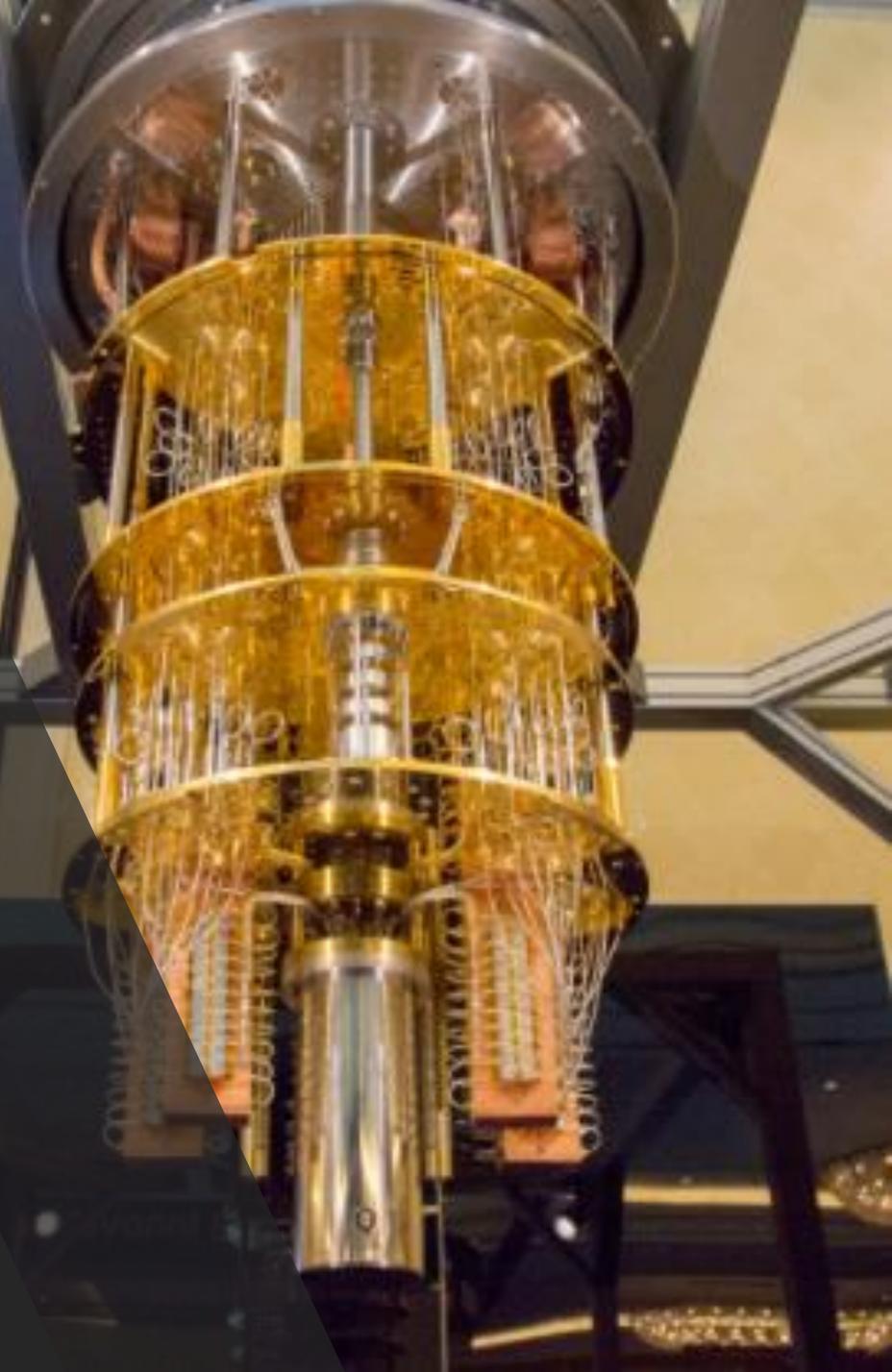
1
5
10
20
50
100
300



2
32
1024
1'048.576
1.12×10^{15}
1.26×10^{30}
2.03×10^{90}

Estimado número de partículas en el Universo 1.10×10^{80}

Procesador Cuántico



IBM Quantum Experience

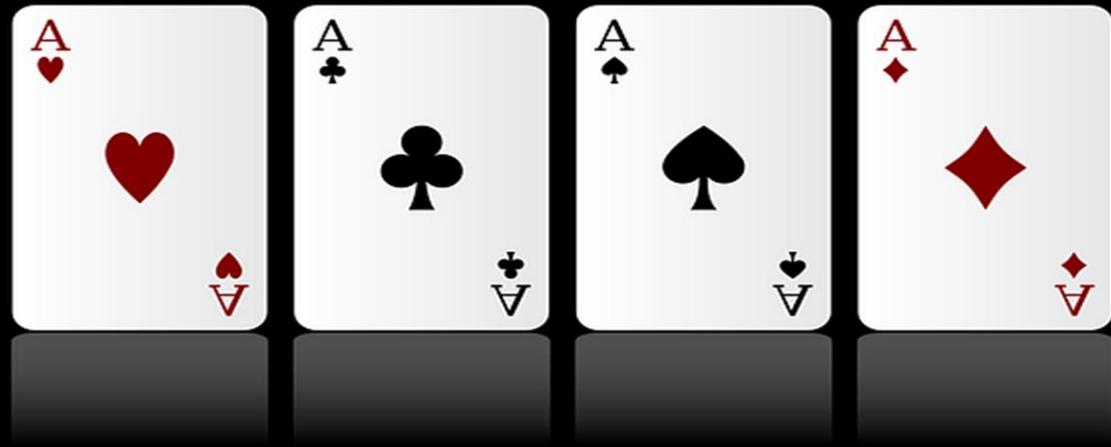
- Experimentos: <https://qe-executions-map.mybluemix.net/>
- Es un procesador cuántico en la nube que está disponible para todo el público a nivel mundial.
- Dispositivos:
<https://quantumexperience.ng.bluemix.net/qx/devices>

Algoritmo de Búsqueda de Grover

N vs \sqrt{N}

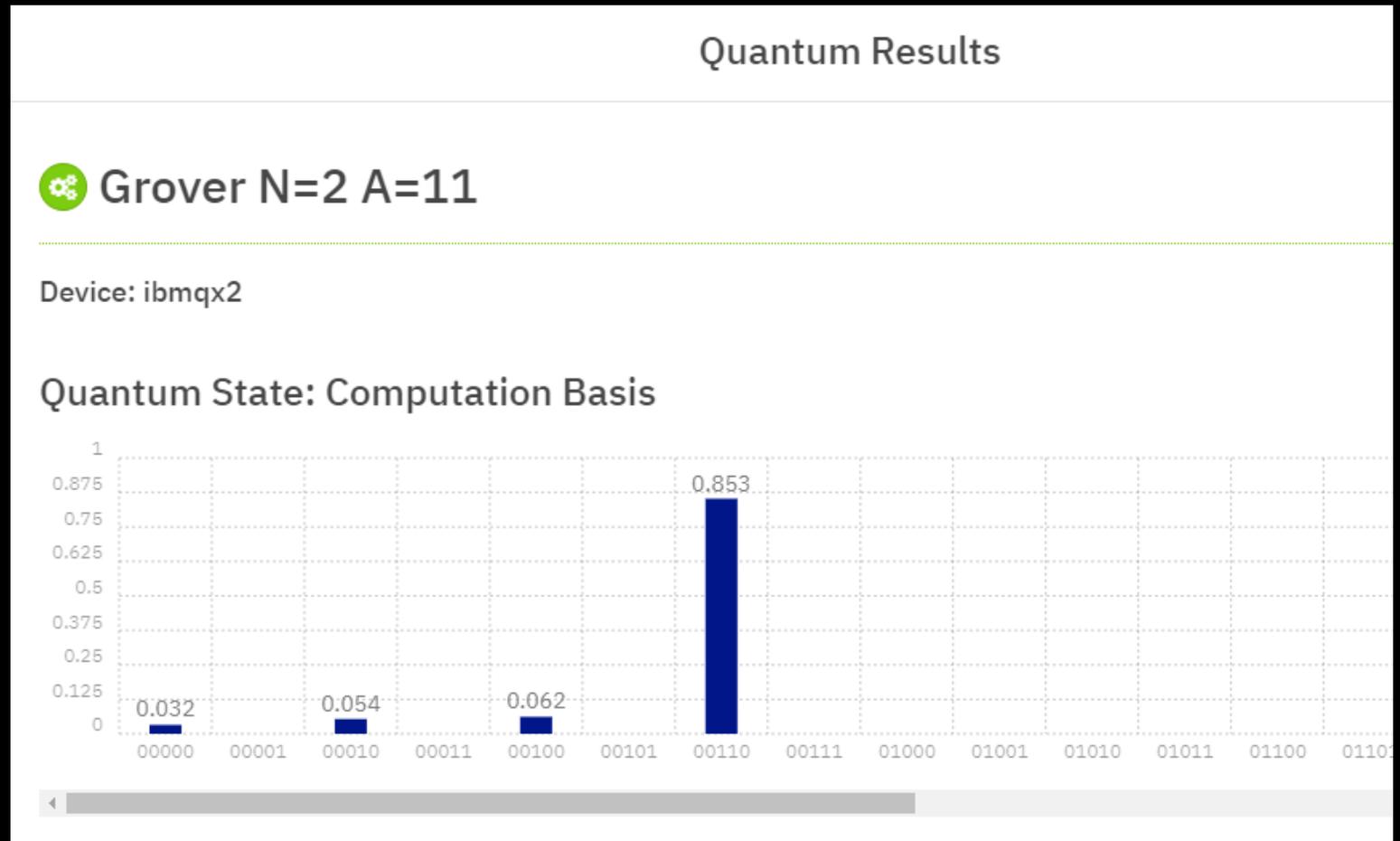
Búsqueda en secuencia de datos desordenada

$$P(\text{Queen}) = \frac{1}{4}$$



Resultado cuántico

$$P(\text{Queen}) = 1$$



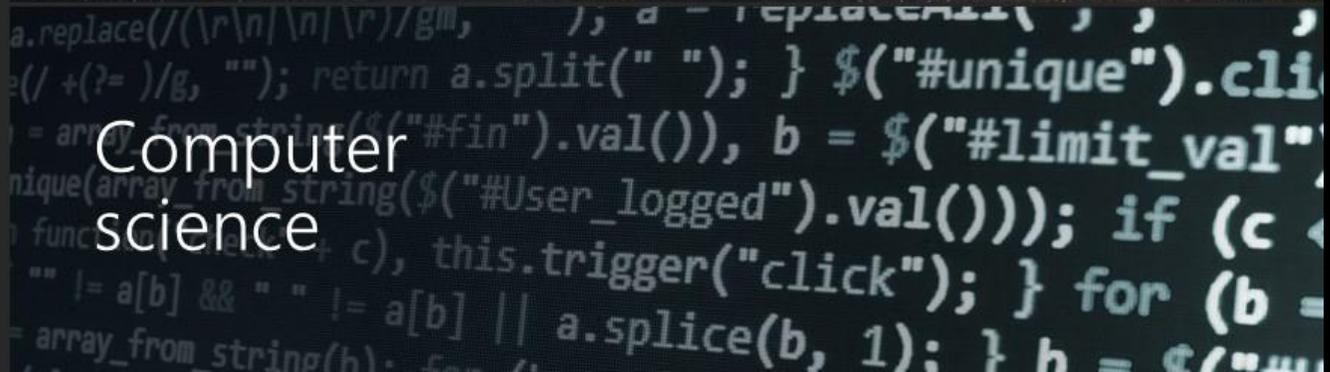
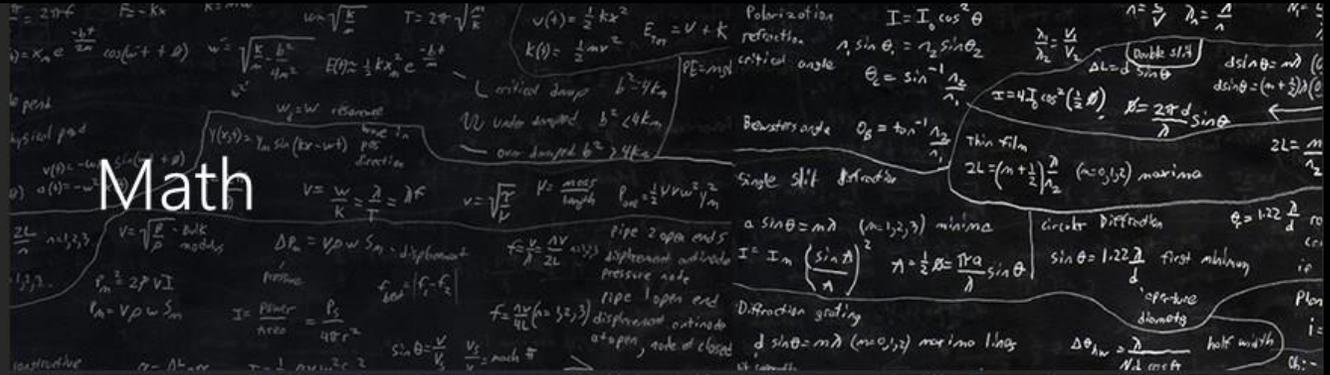
Conclusiones

1

Quantum Computing

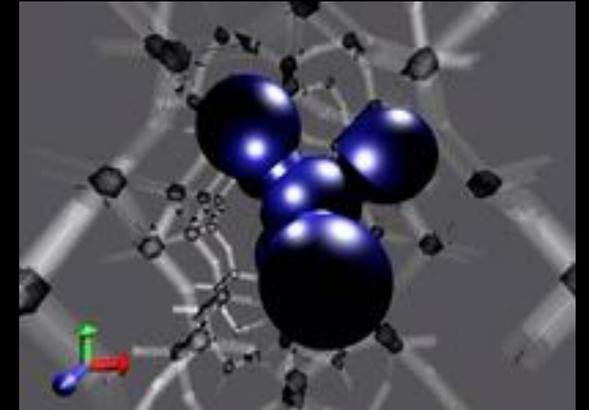
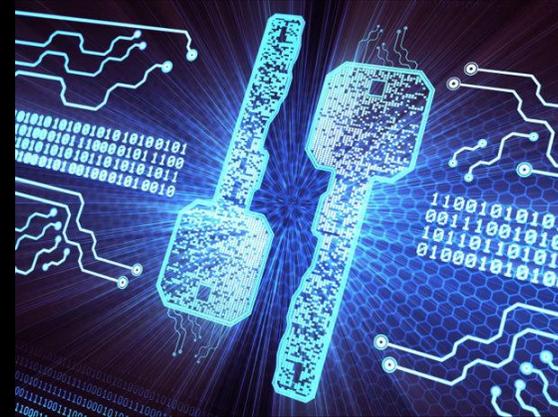
Physics

Computer science



Conclusiones

Criptografía
cuántica



2

Simulación
farmacéutica

Inteligencia Artificial
y Optimización



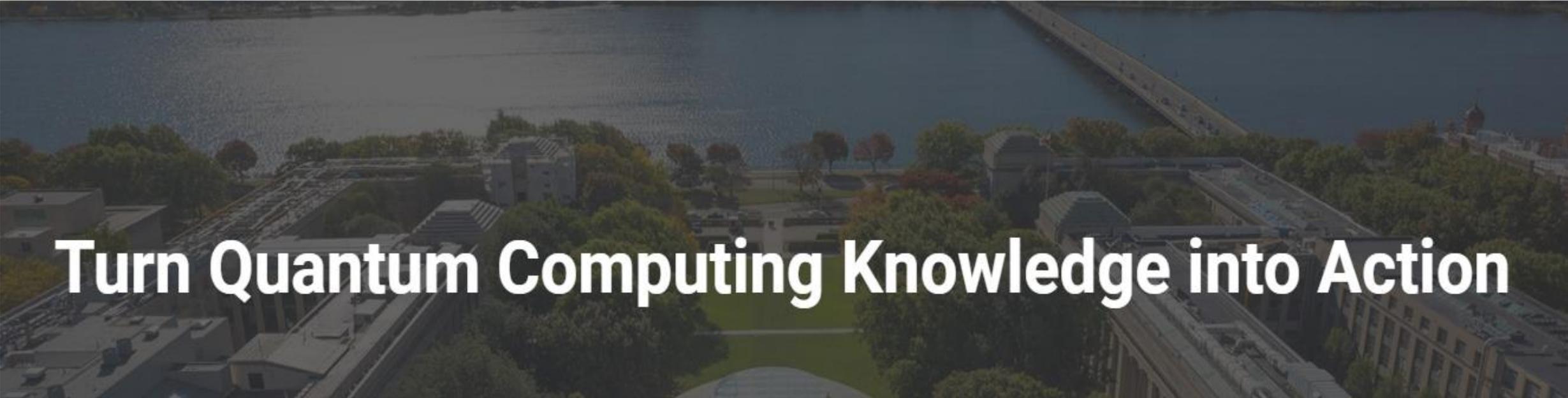
Conclusiones

3

The screenshot displays the IBM Q Experience Composer interface. At the top, the navigation bar includes 'Home', 'Composer', 'Devices', 'Community', 'GitHub', and 'Mateo Laguna'. Below this, a blue header shows two backend options: 'Backend: ibmqx4 (5 Qubits)' with an 'ACTIVE' status, and 'Backend: ibmqx2 (5 Qubits)' with a 'MAINTENANCE' status. The main workspace is titled 'New experiment' and contains buttons for 'New', 'Save', and 'Save as'. A toolbar at the top of the workspace includes 'Switch to Qasm Editor', 'Backend: ibmqx4', 'My Units: 15', 'Experiment Units: 3', 'Run', and 'Simulate'. The central area is a quantum circuit editor with five horizontal lines representing qubits, labeled q[0] |0>, q[1] |0>, q[2] |0>, q[3] |0>, and q[4] |0>. A classical control line is shown at the bottom, labeled 'c 0 5/'. To the right of the circuit is a 'GATES' library with an 'Advanced' toggle. The library includes single-qubit gates: 'id', 'X', 'Y', 'Z', 'H', 'S', 'S†', 'T', and 'T†'. It also includes 'BARRIER' and 'OPERATIONS' sections. A 'light' theme toggle is visible in the bottom right corner.

MIT & IBM

 MIT Quantum Computing Curriculum



Turn Quantum Computing Knowledge into Action

<https://quantumcurriculum.mit.edu/>

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