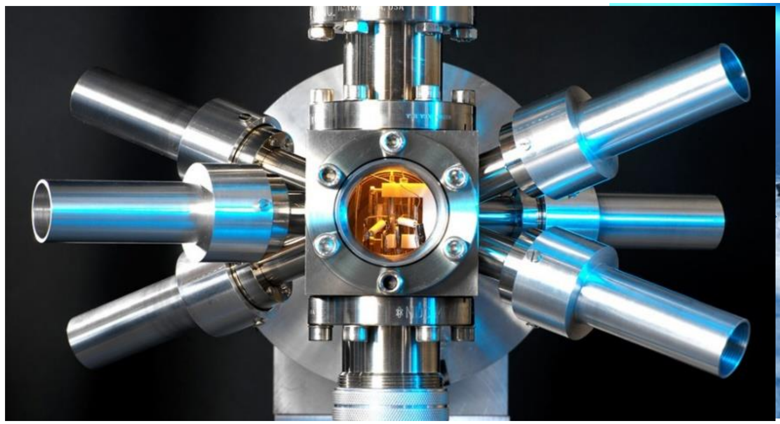
Quantum Computing

IBM

Google AI Quantum

COMUNIDAD DARQ
Claudio R. Parrinello

PRIMERA OLA CUÁNTICA - MECANICA CUANTICA
RESULTADOS DERIVADOS

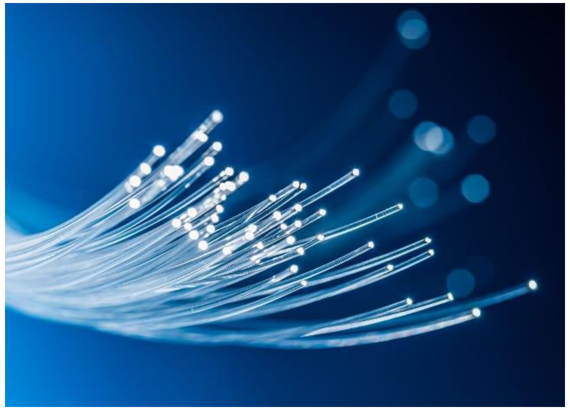


RELOJ ATÓMICO USADO POR LOS SATELITES PARA GPS

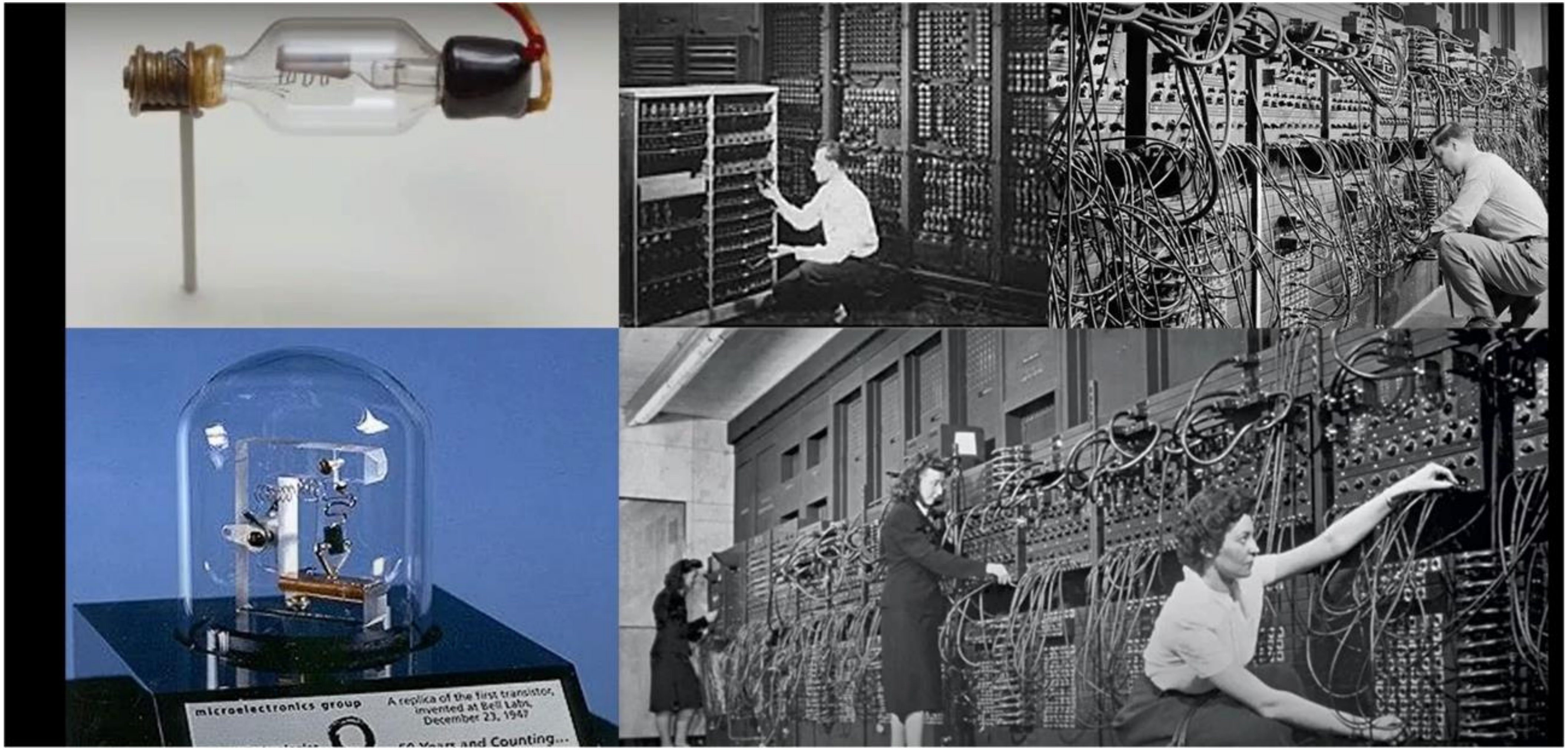
LASER

RESONADOR MAGNETICO

FIBRA OPTICA



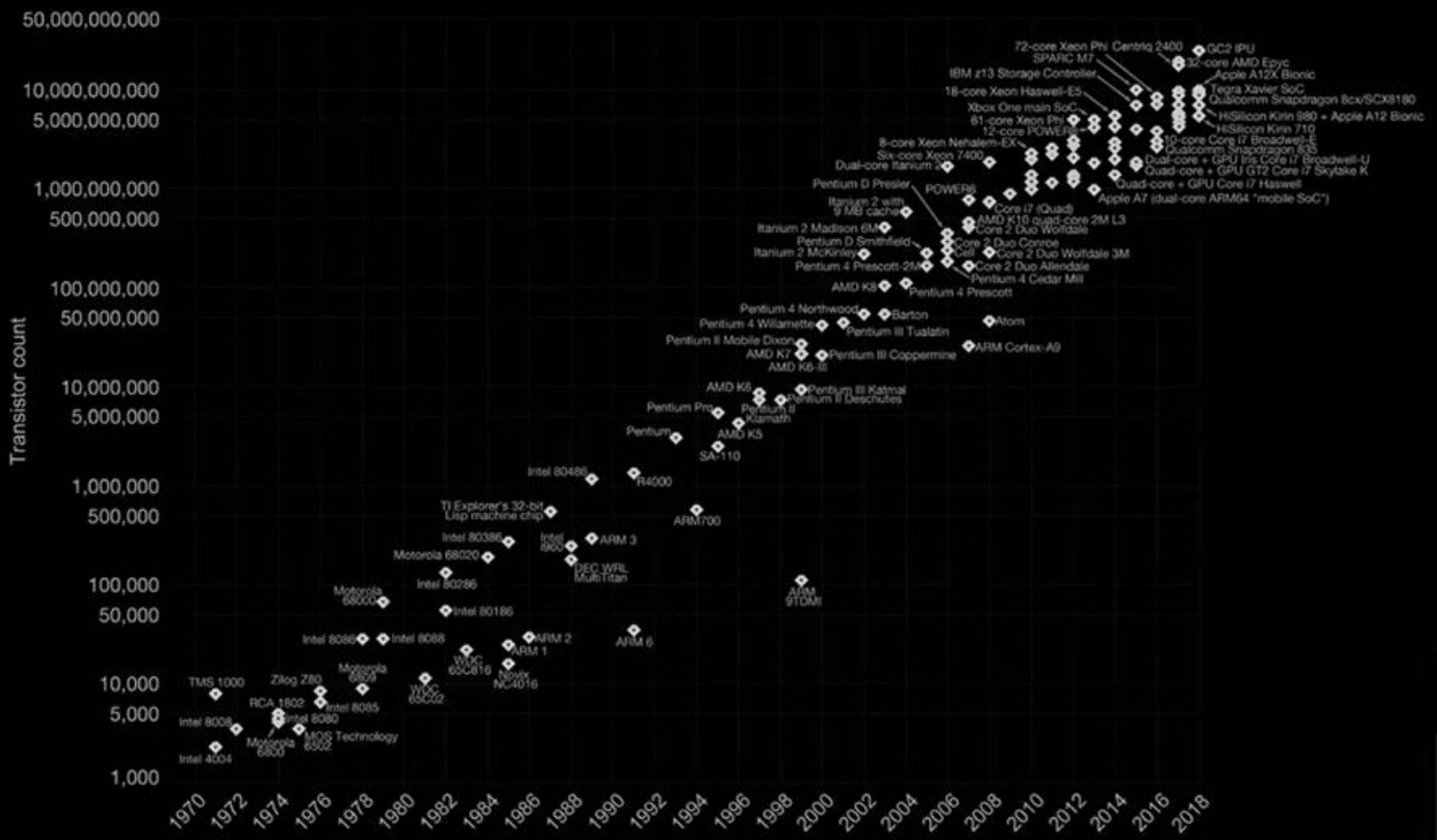
ENIAC : 170 metros cuadrados, 70 mil resistencias, 10 mil condensadores, 1947 propósito general 8 millones de dólares, 1955 duro 18 tubos vacíos 5 millones de soldaduras.



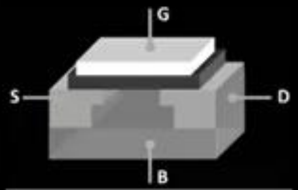
Ley de Moore es que los ordenadores, los componentes que funcionan en ordenadores y la potencia informática se vuelven más pequeños y rápidos con el tiempo, a medida que los transistores de los **circuitos integrados** se vuelven más eficientes.

(The physics of semiconductors).

Semiconductor is a material that is neither a good conductor or a good insulator but that conducts more electricity when heat, light or voltage is added. An example of a semiconductor is <u>silicon</u>.

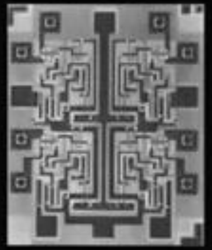


COMUNIDAD DARQ
Claudio R. Parrinello



Metal–Oxide–Semiconductor Field-Effect transistor (MOSFET)

Semiconductor device fabrication

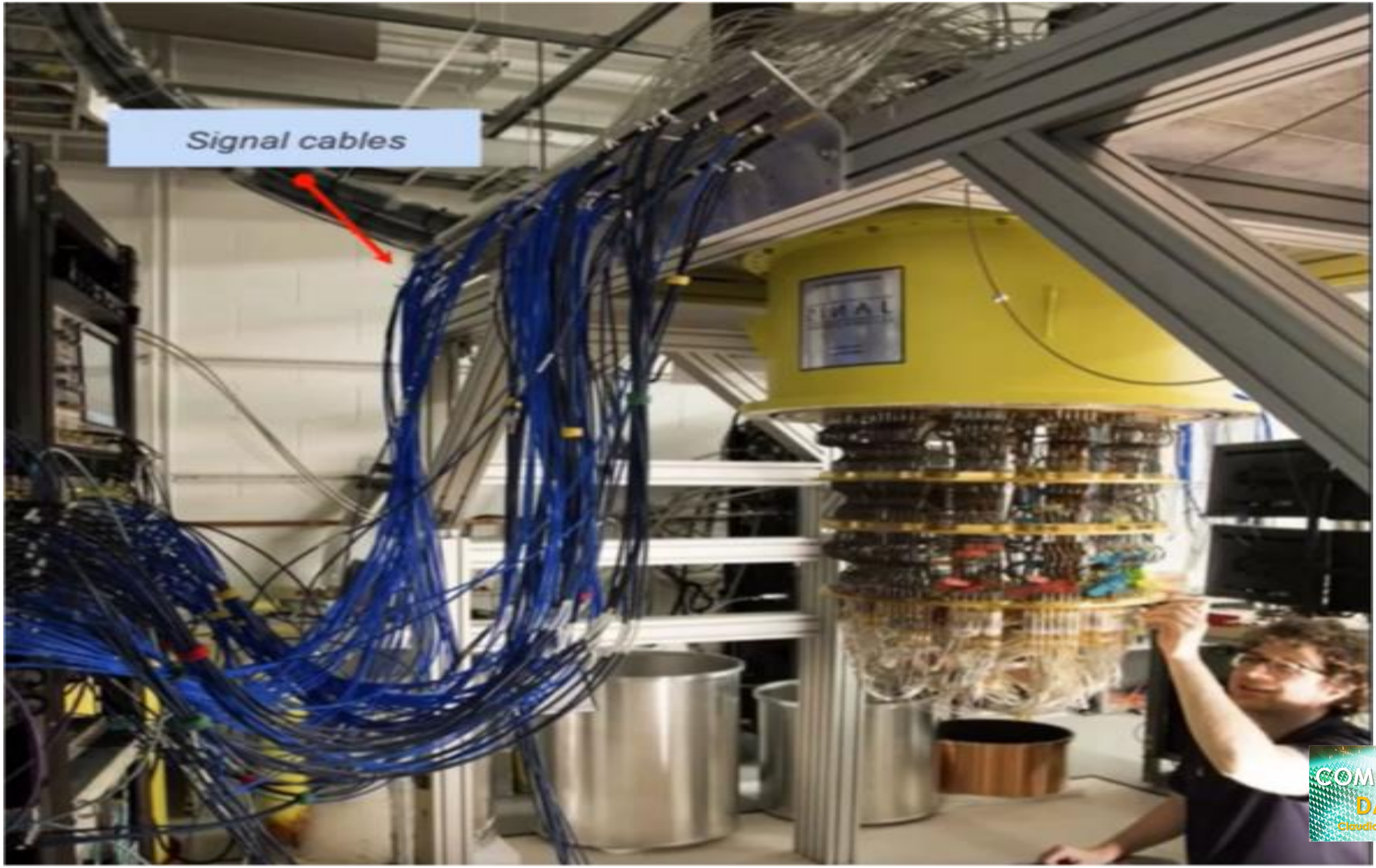


MOSFET scaling (process nodes)

- 10 µm – 1971
- 6 µm – 1974
- 3 µm – 1977
- 1.5 µm – 1981
- 1 µm – 1984
- 800 nm – 1987
- 600 nm – 1990
- 350 nm – 1993
- 250 nm – 1996
- 180 nm – 1999
- 130 nm – 2001
- 90 nm – 2003
- 65 nm – 2005
- 45 nm – 2007
- 32 nm – 2009
- 22 nm – 2012
- 14 nm – 2014
- 10 nm – 2016
- 7 nm – 2018
- 5 nm – 2019

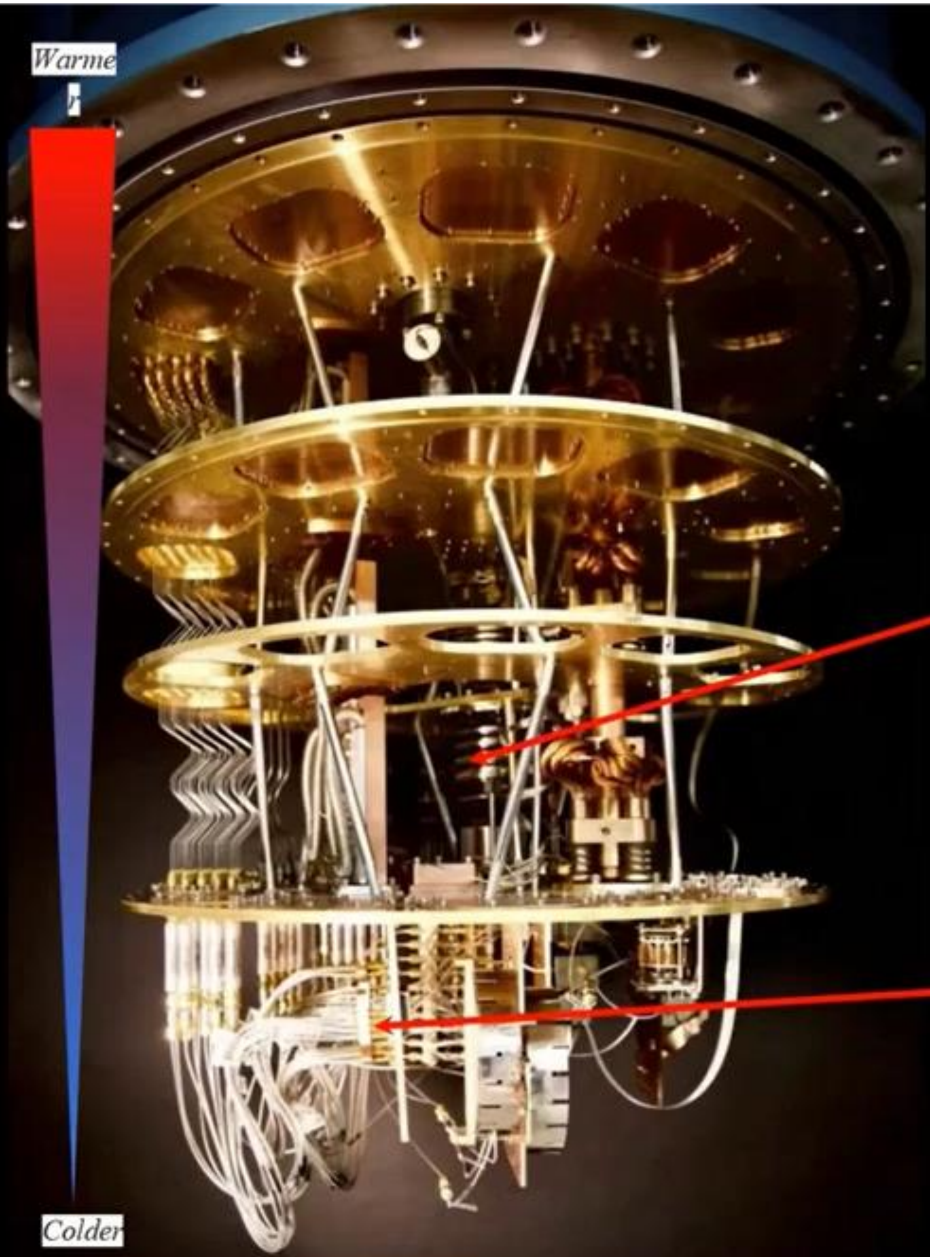
Future

- 3 nm – *~2021*
- 2 nm – *~2024*



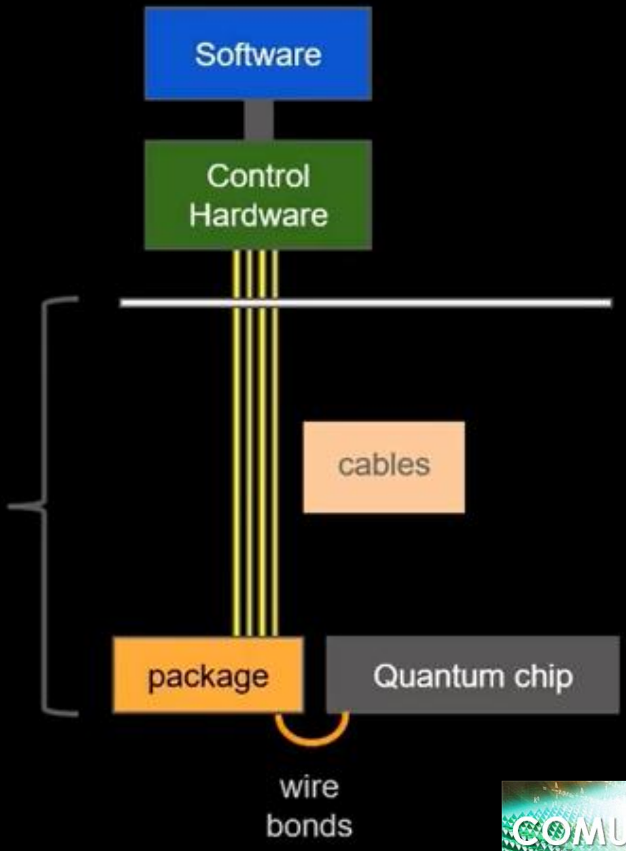
COMUNIDAD
DARQ
Claudio R. Parrinello

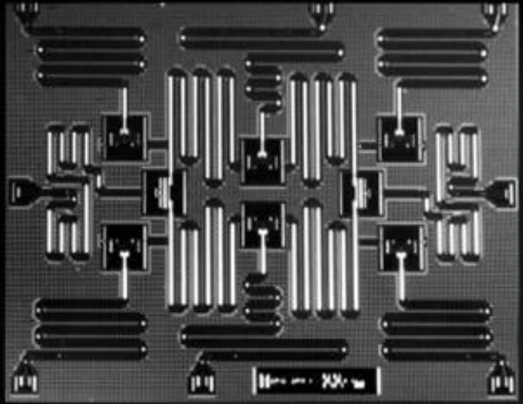
We use superconductor materials that experience no electrical loss at low temperatures

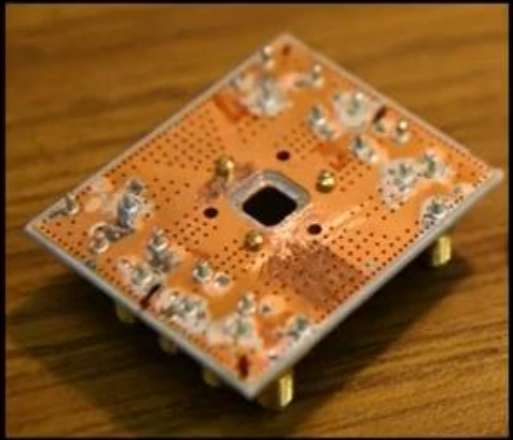


Cryostat core responsible of COLD conditions

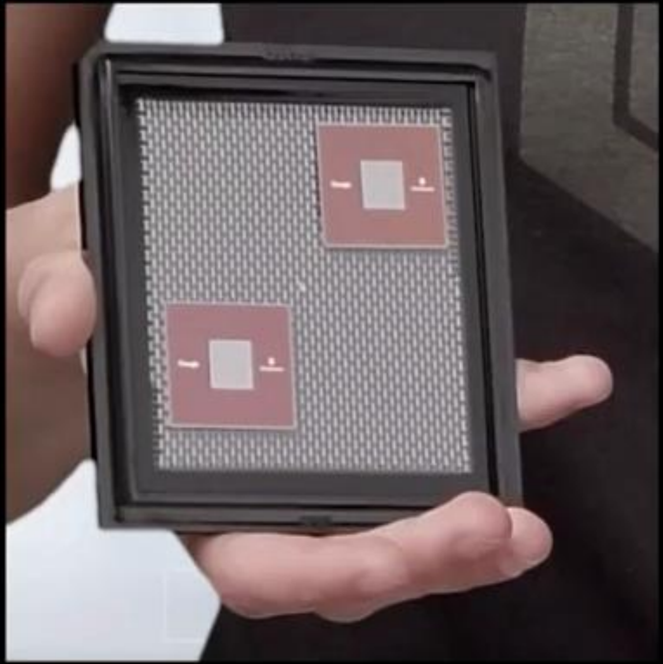
Quantum hardware placed on the edges and bottom of the plates



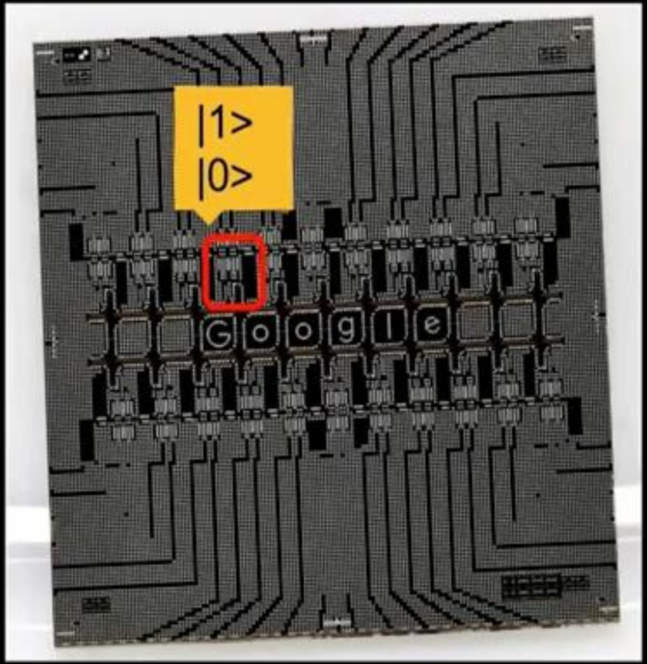




Detailed Circuit board



72-Qubit chip. Used in Sycamore



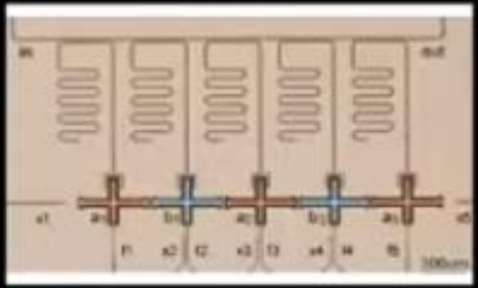
Detailed view of a (2x11) 22-Qubit device

IBM Google AI Quantum

COMUNIDAD DARQ
Claudio R. Parrinello

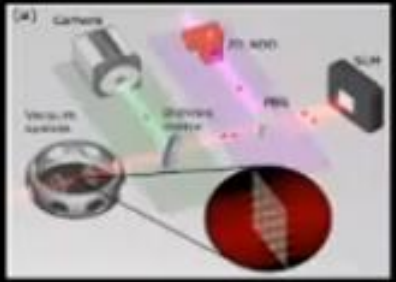
¿Cómo fabricamos un qubit?

Circuitos superconductores



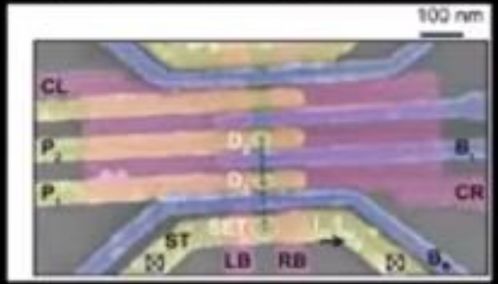
Iones en trampas electromagnéticas

Átomos en trampas ópticas

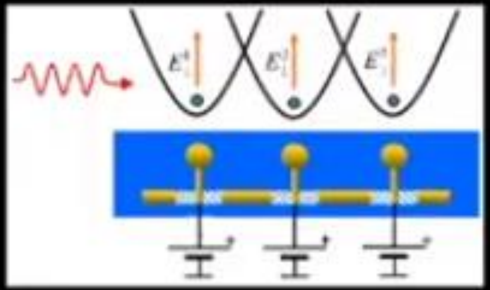


Defectos en diamantes

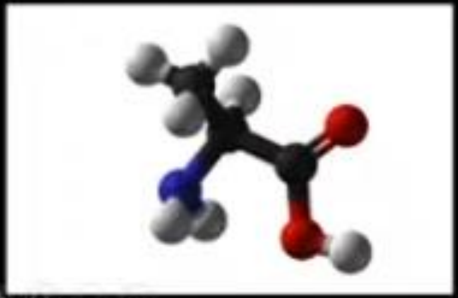
Puntos cuánticos en silicio



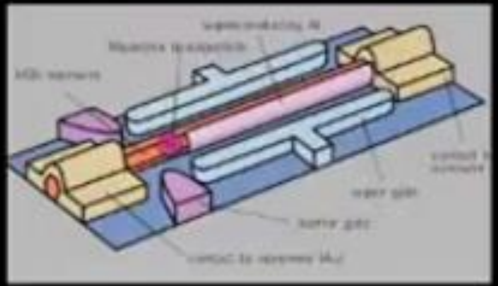
Electrones en helio líquido



Moléculas



Qubits topológicos



Fotones

COMUNIDAD DARQ
Claudio R. Parrinello

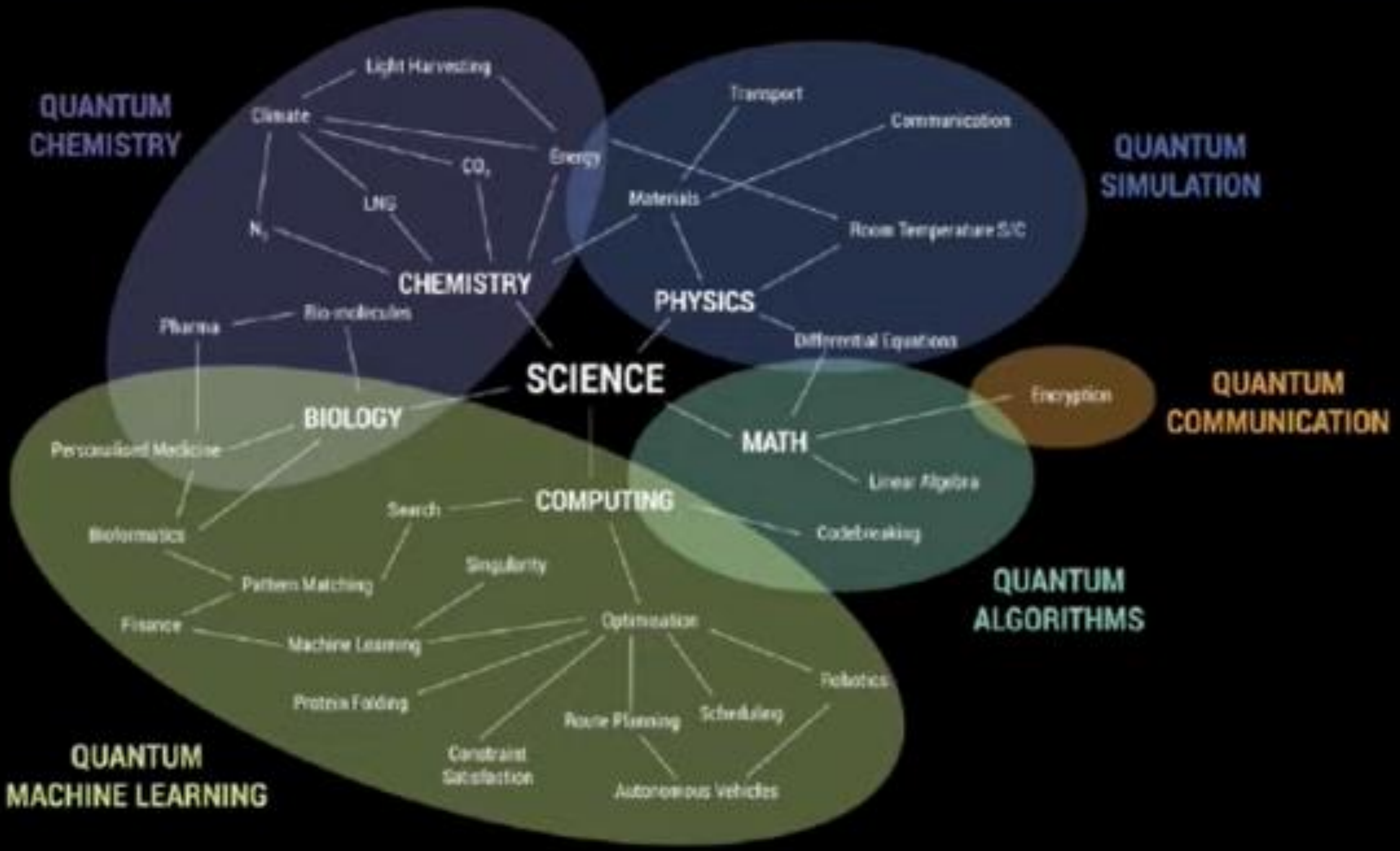
The need of COLD

Thermal energy in a qubit will give it motion, and it's going to decohere any quantum state that you set by allowing the qubit to interact with the environment.

At extremely cold temperatures, atoms and molecules simply move around less. The lower a temperature is, generally speaking, the more stable a molecule becomes.

0 Kelvin (absolute zero) = -273.15 Celsius = -459.67 Fahrenheit!

Quantum Computing Will Revolutionize Science and Technology



COMUNIDAD DARQ
Claudio R. Parrinello

Quantum Computers Use Quantum Bits

- Qubits can be 0 or 1 (heads or tails)
- Or some mixture (**superposition**) of 0 and 1 like a flipping coin
- Combining with **entanglement** can unlock a vast number of states

COMUNIDAD DARQ
Claudio R. Parrinello

Representada por una esfera de radio unidad en R3. cada punto de la superficie de la esfera corresponde unívocamente a un estado puro del espacio de Hilbert de dimensión compleja 2, que caracteriza a un sistema cuántico de dos niveles.

COMUNIDAD DARQ
Claudio R. Parrinello

Remembering Boole

0

1

IBM

Google AI Quantum

COMUNIDAD DARQ

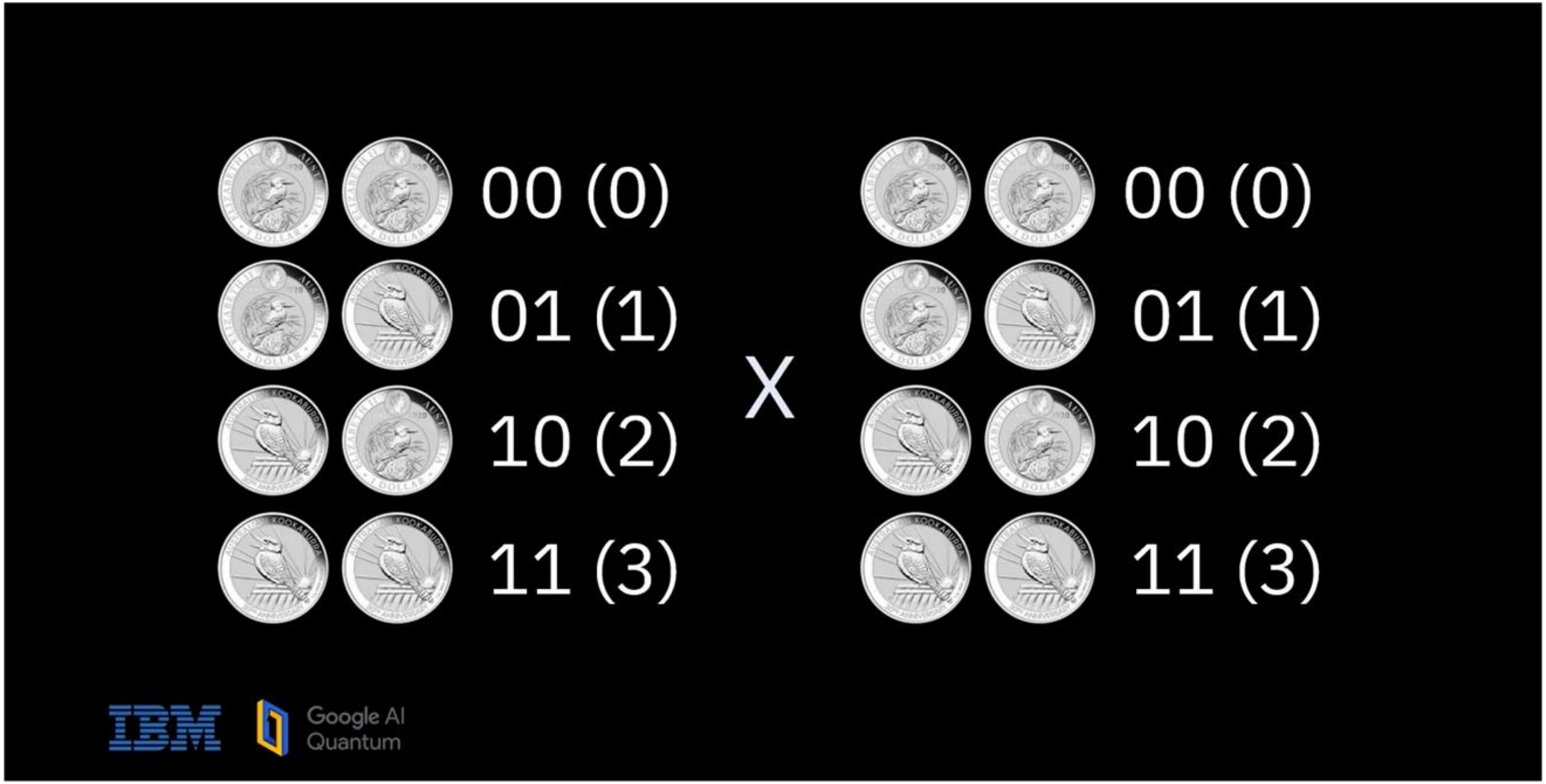
Claudio R. Parrinello

Introducing the qubit

IBM Google AI Quantum

COMUNIDAD DARQ
Claudio R. Parrinello

8 monedas representan NROS 0 a 3 en cuántica 2 monedas


00 (0)
01 (1)
10 (2)
11 (3)
X
00 (0)
01 (1)
10 (2)
11 (3)
IBM
Google AI
Quantum

Todos los números a la vez del 0 al 1023

Decimal = $b_0 * 2\ b^0 + \ldots.\ b_{n-1} * 2\ b^{n-1}$ En este caso para el binario 1111111111
$+ 1 * 2^9 + 1 * 2^8 + 1 * 2^7 + 1 * 2^6 + 1 * 2^5 + 1 * 2^4 + 1 * 2^3 + 1 * 2^2 + 1 * 2^1 + 1 * 2^0 = + 1 * 1 + 1 * 2 + 1 * 4 + 1 * 8 + 1 * 16 + 1 * 32 + 1 * 64 + 1 * 128 + 1 * 256 + 1 * 512$
$= + 1 + 2 + 4 + 8 + 16 + 32 + 64 + 128 + 256 + 512 = 1023$

0000000000	0
1110000100	900
1111100111	999
1111111111	1023

N=10 monedas 10 qubits

10 posiciones x
1024 nros.
10240 BITS

2 **N = 1024

COMUNIDAD DARQ
Claudio R. Parrinello

¿Las computadoras cuánticas reemplazaran a las computadoras actuales?

Respuesta: nop!! porque las computadoras cuánticas son especiales para un tipo de calculo específico.

Querés ver un video mejor una computadora clásica que una cuántica, porque seguro va a ser mas rápida para esa función seguramente el mundo será un mix de ambas cosas.

COMUNIDAD
DARQ
Claudio R. Parrinello

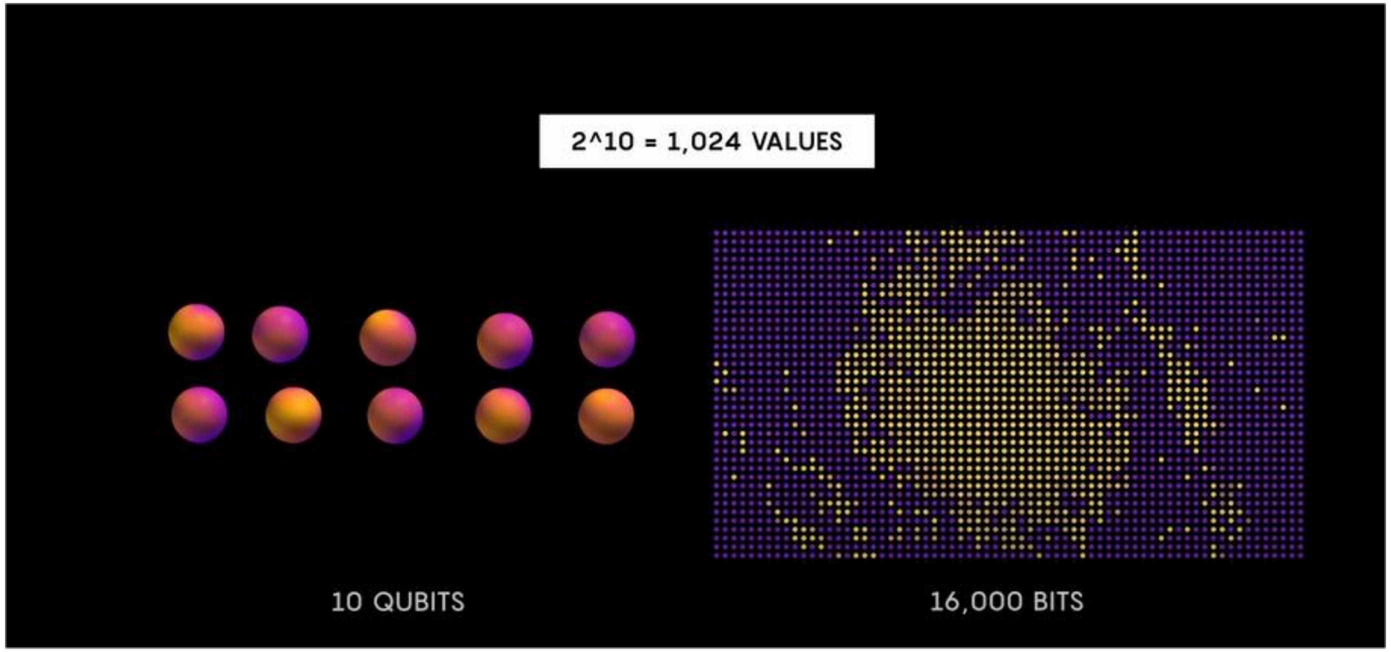
Representing molecules

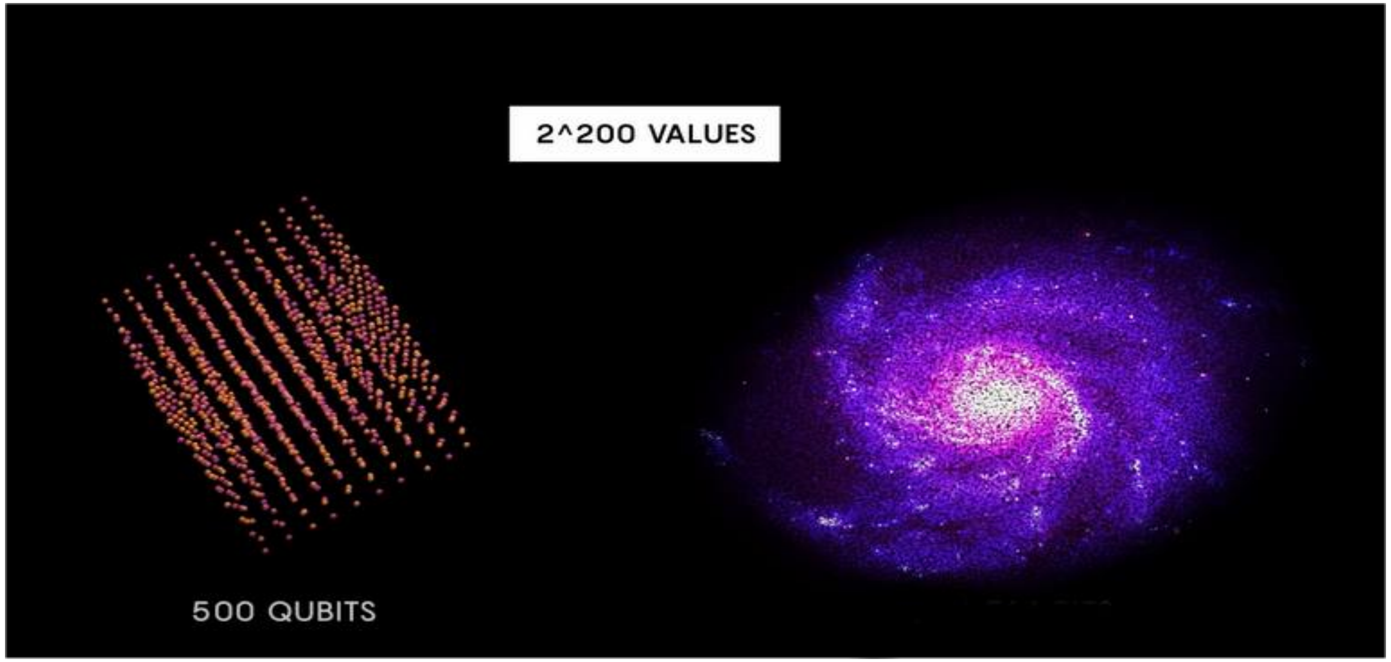
	Chemical formula	Classical bits	Qubits
Water	H_2O	10^4	14
Ethanol	C_2H_6O	10^{12}	42
Acetaminophen	$C_8H_9NO_2$	10^{36}	120
Caffeine	$C_8H_{10}N_3O_2$	10^{48}	160
Sucrose	$C_{12}H_{22}O_{11}$	10^{82}	274
Penicillin	$C_{16}H_{18}N_2NaO_4S$	10^{86}	286

Within a few years we hope to be able to exactly represent larger molecular energy states in a quantum computer.

IBM Google AI Quantum

COMUNIDAD DARQ
Claudio R. Parrinello





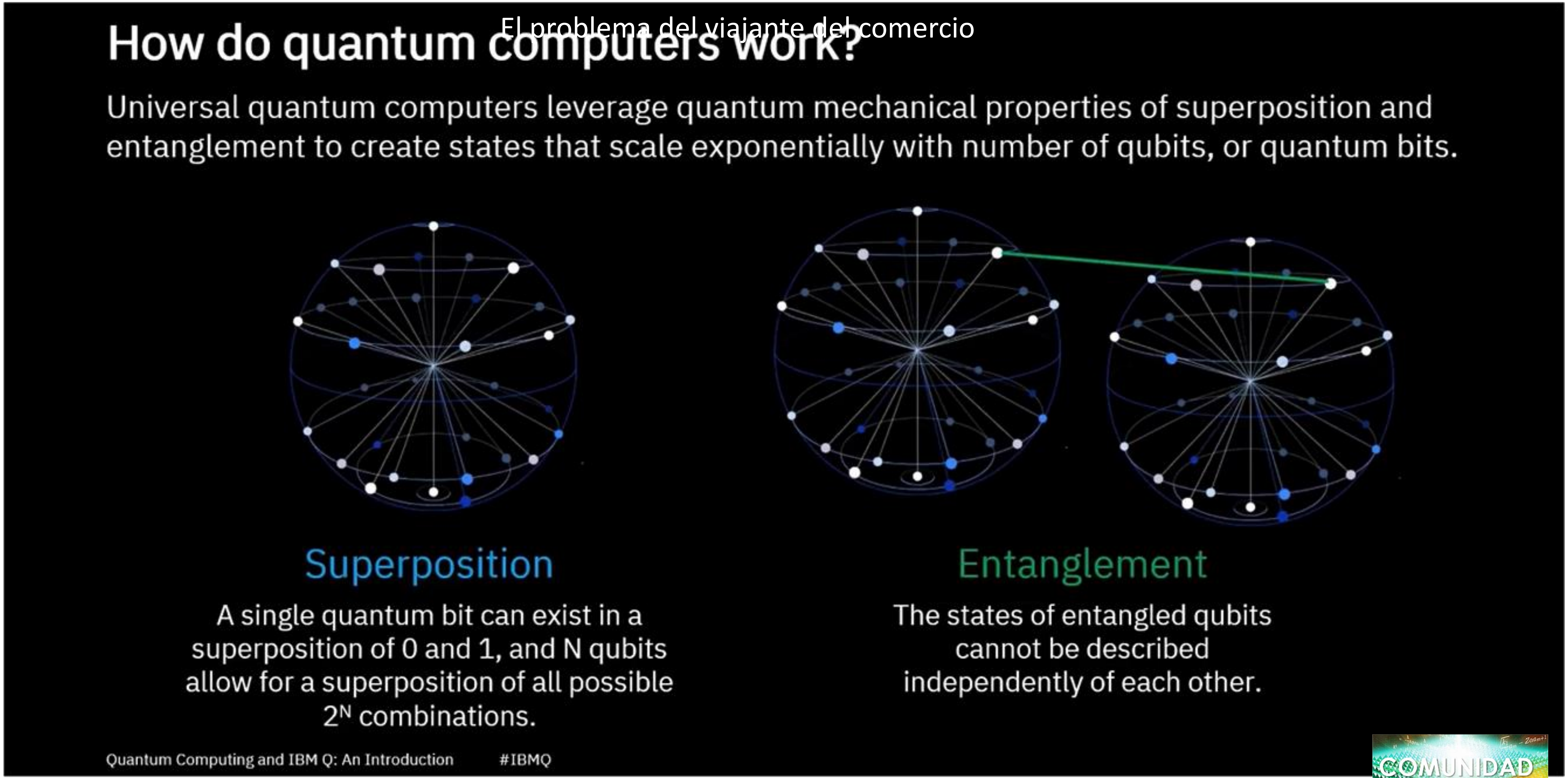
Futuro próximo

IBM y GOOGLE

1000 Qubits 2 años
1 Millón Qubits 10 años

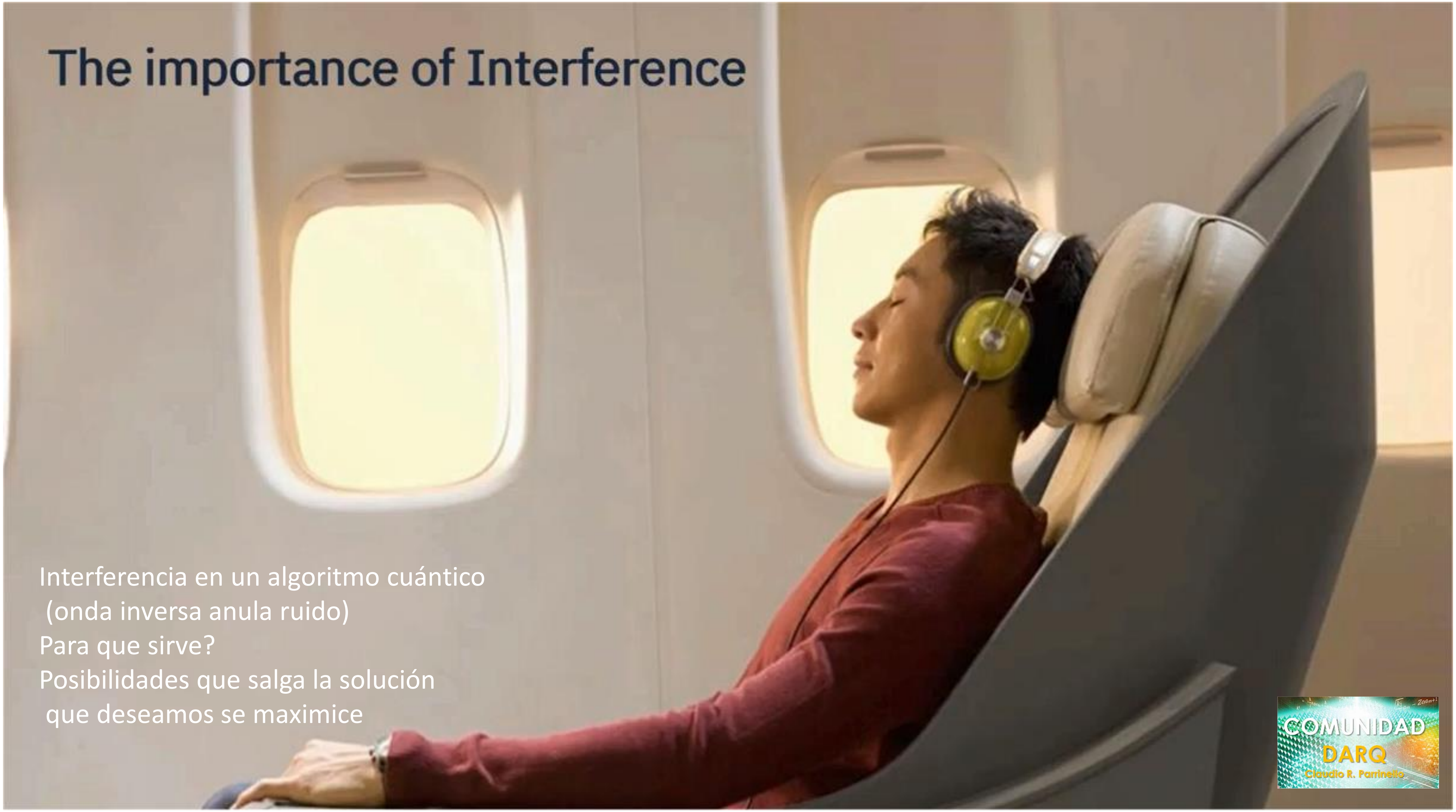
COMUNIDAD DARQ
Claudio R. Parrinello

El problema del viajante del comercio



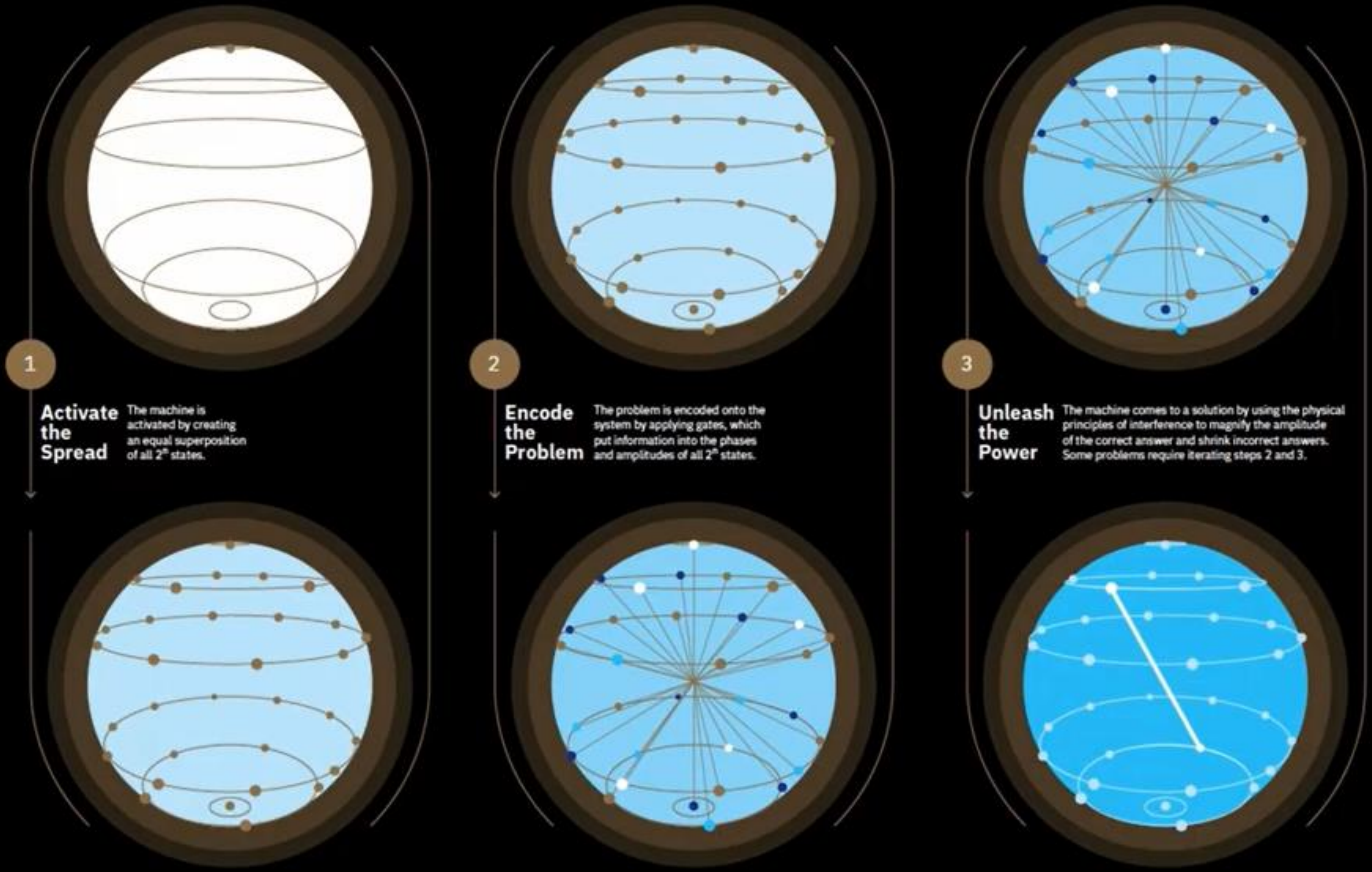
COMUNIDAD DARQ
Claudio R. Parrinello

The importance of Interference



Interferencia en un algoritmo cuántico
(onda inversa anula ruido)
Para que sirve?
Posibilidades que salga la solución
que deseamos se maximice

Quantum algorithms schema



COMUNIDAD DARQ
Claudio R. Parrinello

Condiciones para construir un ordenador cuántico

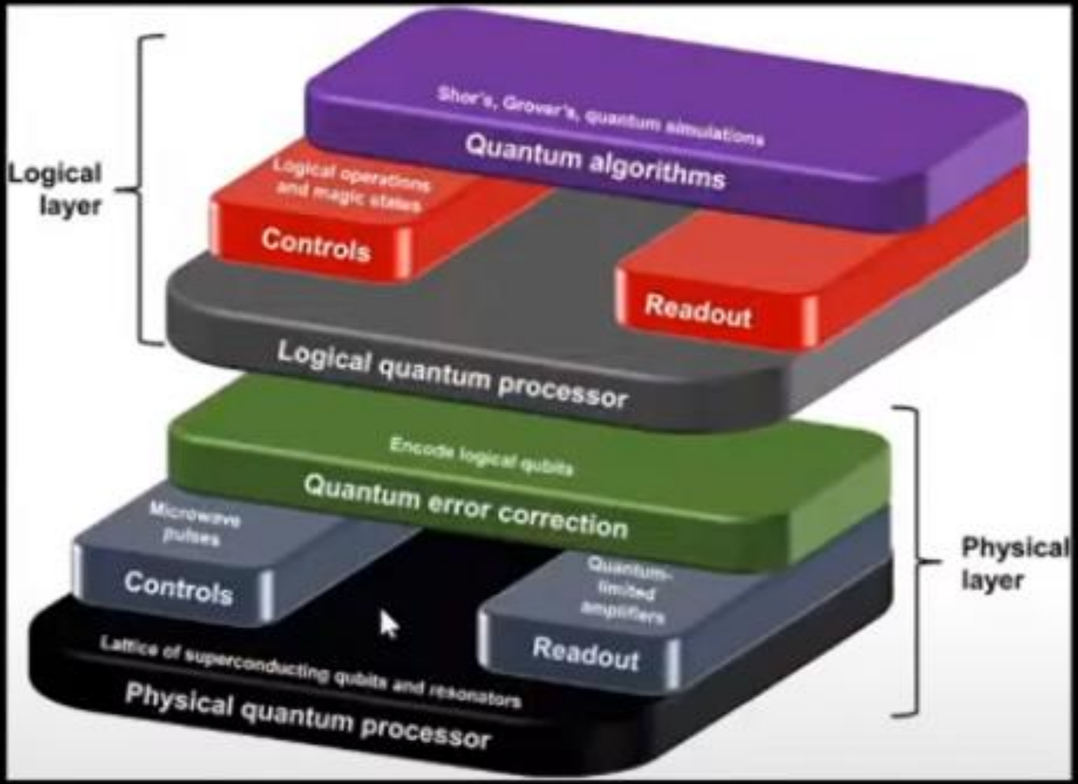
1: Sistema escalable con qubits bien caracterizados

2: Capacidad de inicializar los qubits

3: Tiempo de decoherencia mucho mayor que el tiempo de una operación

4: Conjunto universal de puertas cuánticas

5: Capacidad de medir el estado de los qubits



COMUNIDAD DARQ
Claudio R. Parrinello

How does nature do this??

Copenhagen interpretation

Many-worlds

Ensemble interpretation

Quantum logic

Stochastic mechanics

Consistent Histories

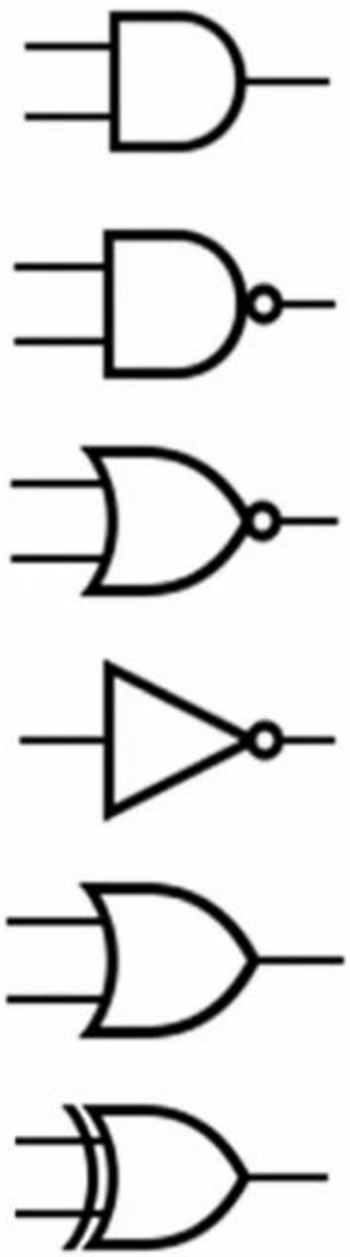
Object collapse

De Broglie–Bohm theory

COMUNIDAD
DARQ
Claudio R. Parrinello

All computers, from mobile devices, to desktops, to cloud servers to supercomputers are based on these logical gates.

The interesting part:
most of these are **not reversible**



AND GATE

Input A	Input B	Output
0	0	0
1	0	0
0	1	0
1	1	1

NAND GATE

Input A	Input B	Output
0	0	1
1	0	1
0	1	1
1	1	0

NOR GATE

Input A	Input B	Output
0	0	1
1	0	0
0	1	0
1	1	0

NOT GATE

Input	Output
I	F
0	1
1	0

OR GATE

Input A	Input B	Output
0	0	0
1	0	1
0	1	1
1	1	1

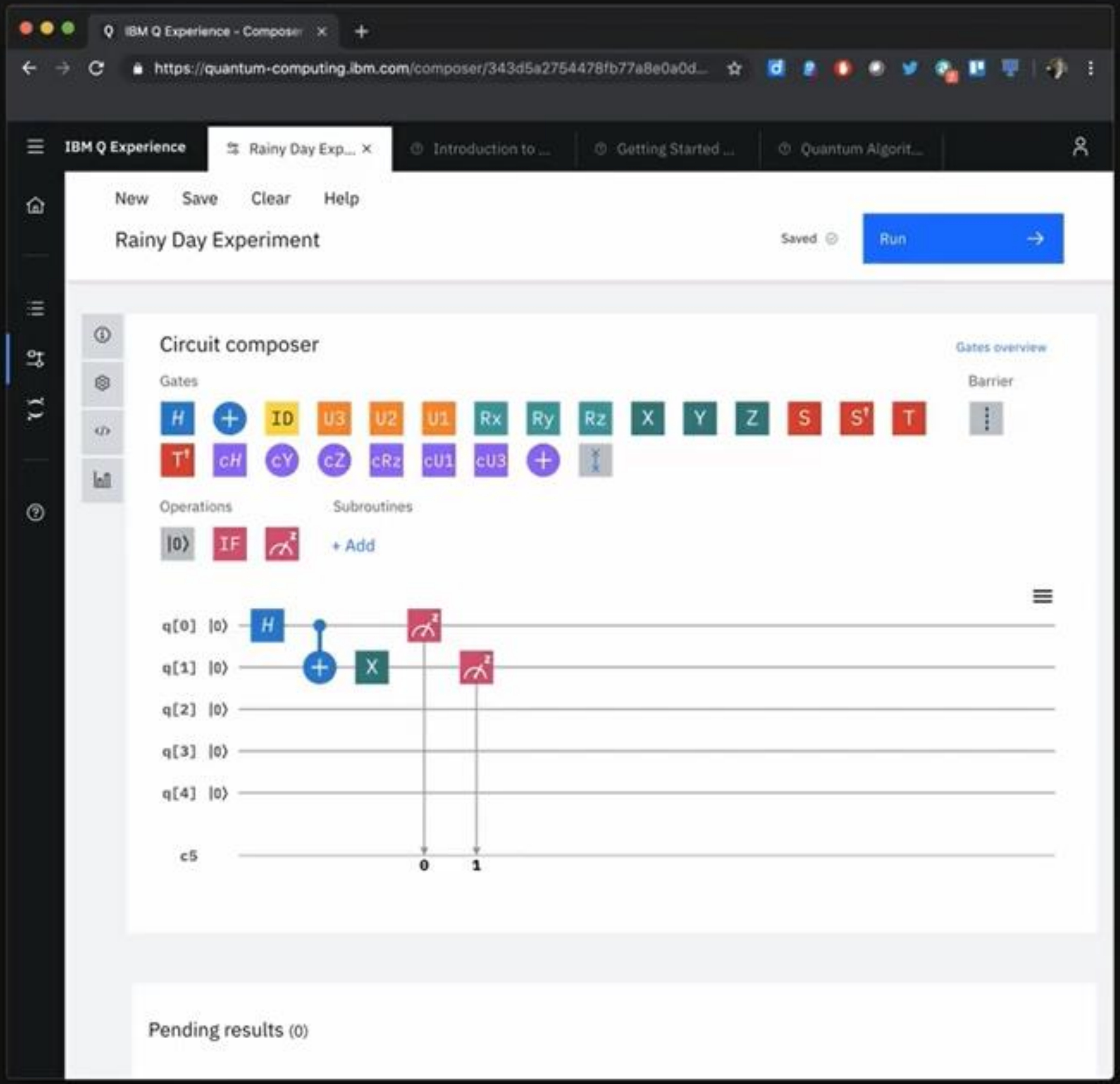
XOR GATE

Input A	Input B	Output
0	0	0
1	0	1
0	1	1
1	1	0

COMUNIDAD DARQ
Claudio R. Parrinello

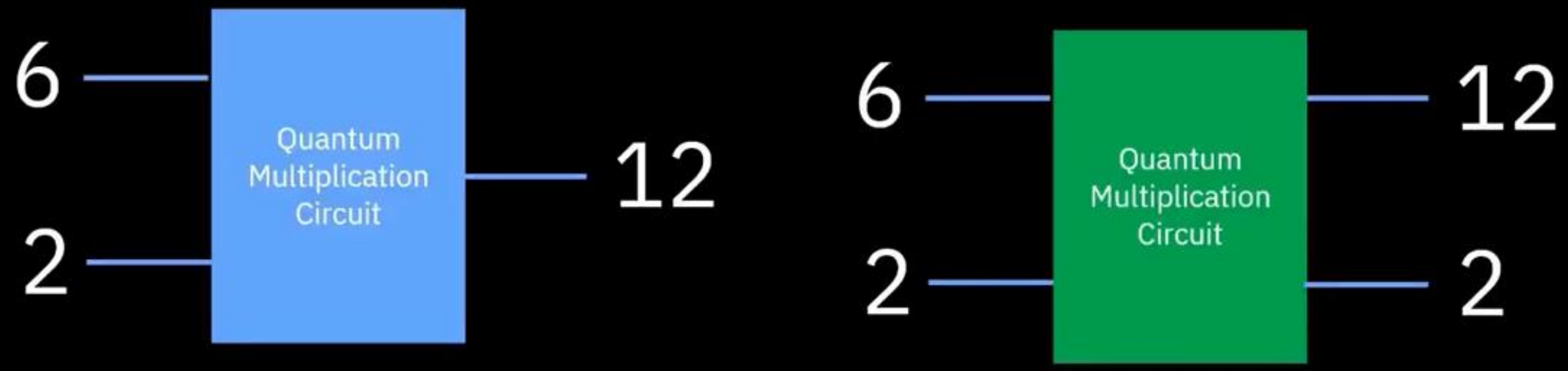
Creating Circuits

Graphically build, debug, and run quantum circuits on IBM Q hardware systems and simulators.



IBM Google AI Quantum COMUNIDAD DARQ Claudio R. Parrinello

Quantum circuits MUST be reversible



IBM Google AI Quantum

COMUNIDAD DARQ
Claudio R. Parrinello

LAS DIFICULTADES QUE PLANTEAN LOS ORDENADORES CUÁNTICOS

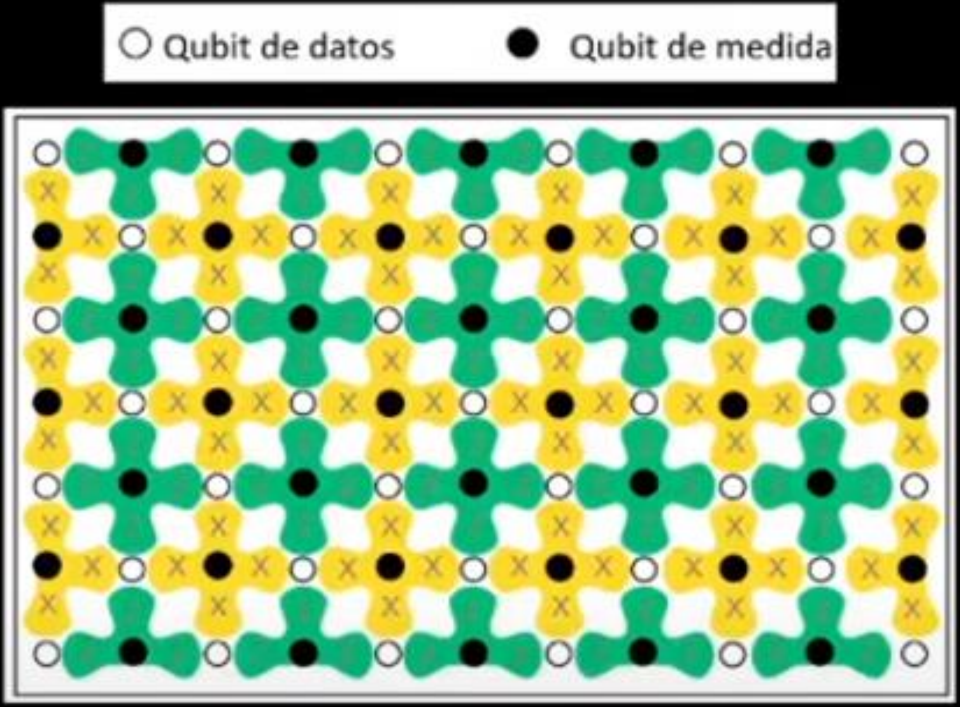
- **Interferencia** – Durante la fase de cálculo de un cálculo cuántico, la más mínima perturbación en un sistema cuántico (por ejemplo, un fotón errante o una onda de radiación electromagnética) provoca el fallo del mismo, en un proceso que se conoce como decoherencia. Los ordenadores cuánticos deben estar totalmente aislados de toda interferencia externa durante la fase de cálculo.

- **Corrección de errores** -Dada la naturaleza de la computación cuántica, la corrección de errores es de vital importancia, dado que un único error en un cálculo puede invalidar la totalidad del proceso computacional.

- **Observancia de los resultados** -Íntimamente relacionado con los dos anteriores, la captura de los resultados del cálculo cuántico también entraña un riesgo de corrupción de datos.

COMUNIDAD
DARQ
Claudio R. Parrinello

Computación cuántica con tolerancia a errores



Surface code

- Umbral de error ~ 0.005 – 0.01
- Número de qubits físicos 1000 – 10000 por qubit lógico
- Depende del modelo de errores que estemos usando

Eg: Factorizar número 2048 bits

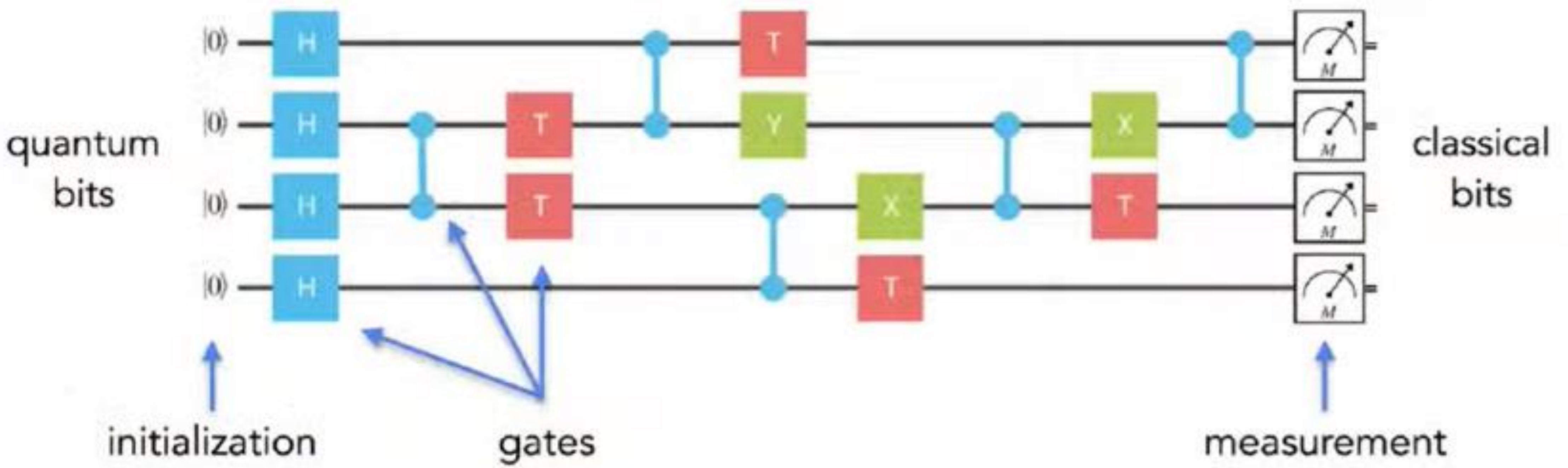
- 20000000 qubits físicos
- 8h

Suponiendo

- Ciclo de Surface code 1 μs
- Tasa de error de qubit de 0.001
- Errores aleatorios e independientes

COMUNIDAD DARQ
Claudio R. Parrinello

Quantum Program or Circuit



COMUNIDAD DARQ
Claudio R. Parrinello

Programming in a "nicer way"

Qiskit

A foundation for advancing quantum science with open source tools and capabilities in a modular framework.

IBM

Google AI Quantum

Qiskit community

Qiskit is driven by our avid community of Qiskitters! We are committed to our goal of bringing quantum computing to people of all backgrounds, and are always excited to hear your feedback directly from you. There are many ways to stay informed, contribute to, and collaborate on Qiskit.

- Slack
- GitHub
- Stack Exchange
- Twitter
- Medium
- YouTube
- Facebook

COMUNIDAD DARQ
Claudio R. Parrinello

Algoritmo de Deutsch-Jozsa, Algoritmo de Shor y Algoritmo de Grover

El Algoritmo de Shor, basado en resultados de álgebra, calcula valores de la función usando los estados de varios qubits para combinar todos esos resultados de tal forma que, al medir el estado de los qubits, se obtenga el período de la función de forma aproximada. RSA algoritmos pos cuánticos.

Algoritmo de Grover, nueva forma de realizar una búsqueda normal de un dato, sin este algoritmo los datos tendrían que ser ordenados previamente para realizar una inspección lineal, en cambio con el algoritmo de Grover no sería necesario.

El algoritmo de Deutsch y Jozsa ilustra la reducción, proporcionada por el cómputo cuántico, en la complejidad del procesamiento.
Una propiedad importante de la computación cuántica es su paralelismo implícito, que permite procesar un número exponencial de transformaciones básicas mediante un número lineal de qubits en un sistema cuántico.

COMUNIDAD DARQ
Claudio R. Parrinello

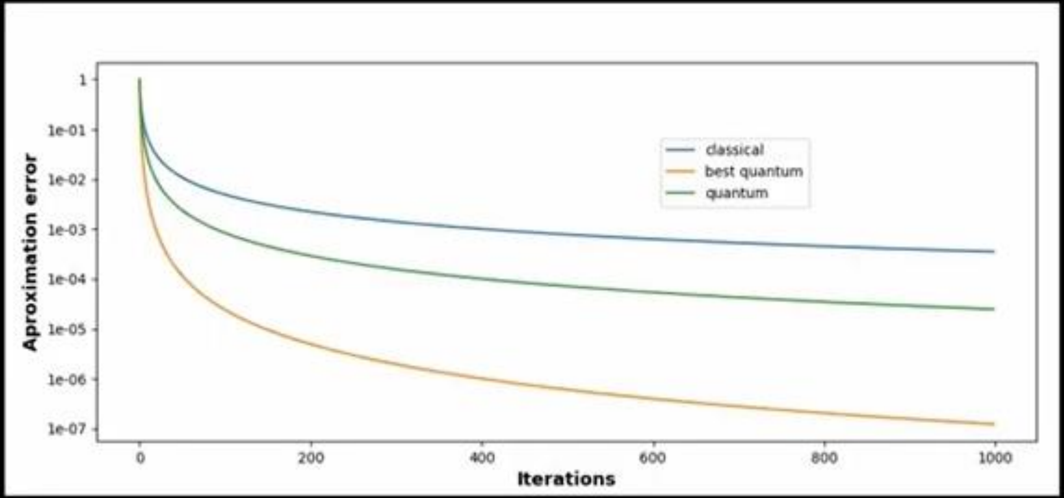
Montecarlo simulations – Quantum Algorithm

COMUNIDAD
DARQ
Claudio R. Parrinello

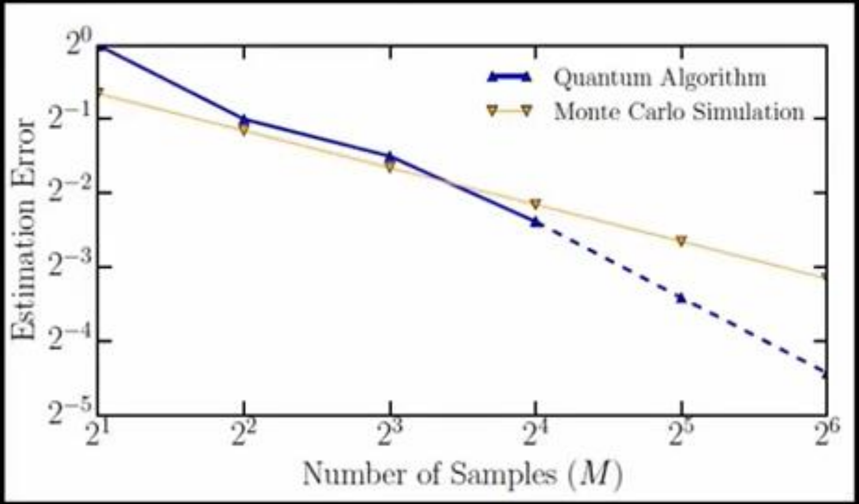
Quantum algorithm can achieve the same level of accuracy with **fewer simulations**.

Theoretical convergence rate:

- Classical algorithm $O(M^{-\frac{1}{2}})$
- Quantum algorithm $O(M^{-\frac{2}{3}})$
- Best quantum algorithm $O(M^{-1})$



Tested convergence rate



https://arxiv.org/pdf/1806.06893.pdf

The most famous Quantum Algorithm

$$N = p * q$$

15 = 3 * 5
124711 = 401 * 311
18848997157 = 13729 × 1372933

From
28.000.000.000.000.000.000.000
years, to...

100 seconds

Algoritmo de shore   RSA algoritmos pos cuánticos

COMUNIDAD DARQ
Claudio R. Parrinello

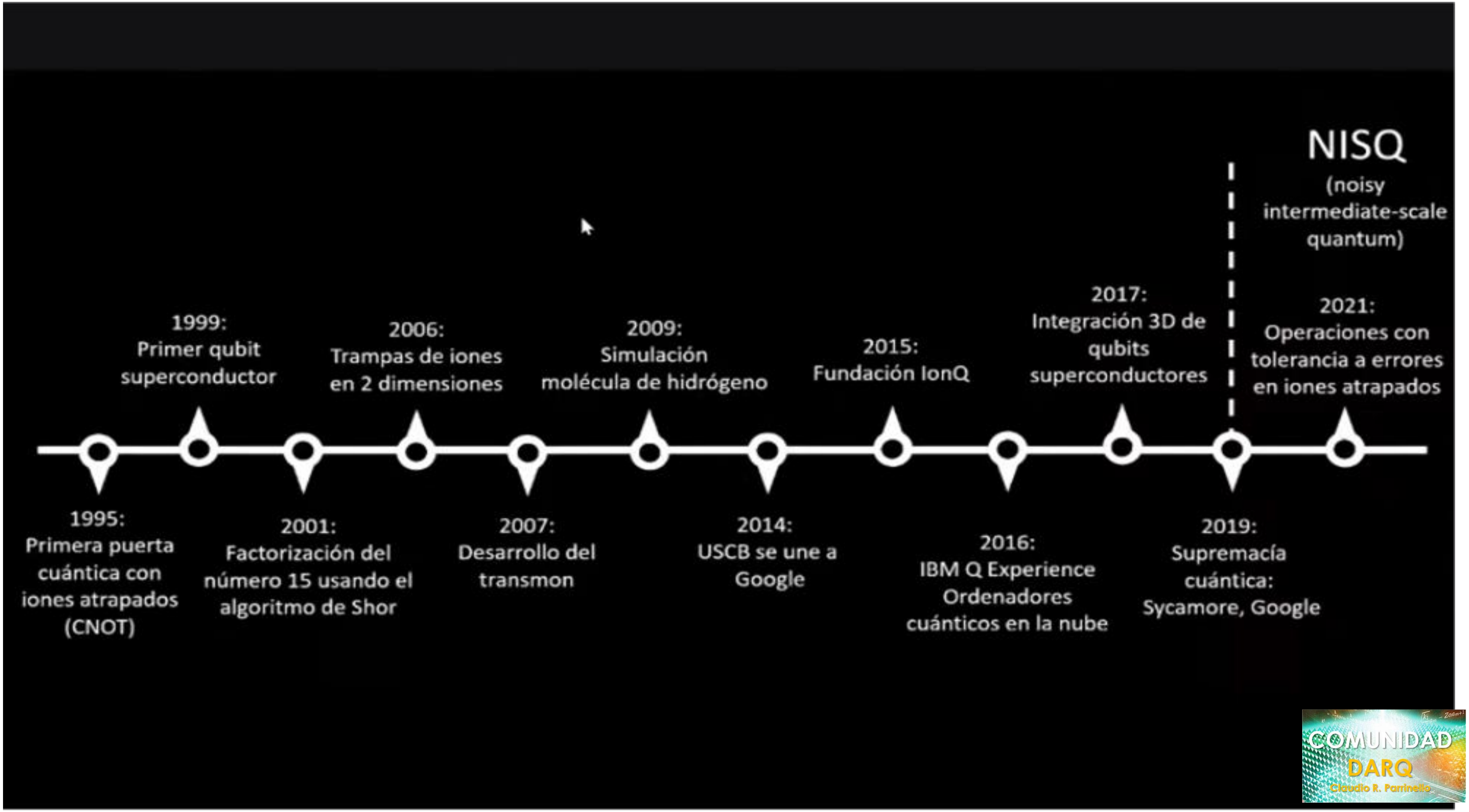
October 23, 2019: Quantum Supremacy

Google confirms 'quantum supremacy' breakthrough

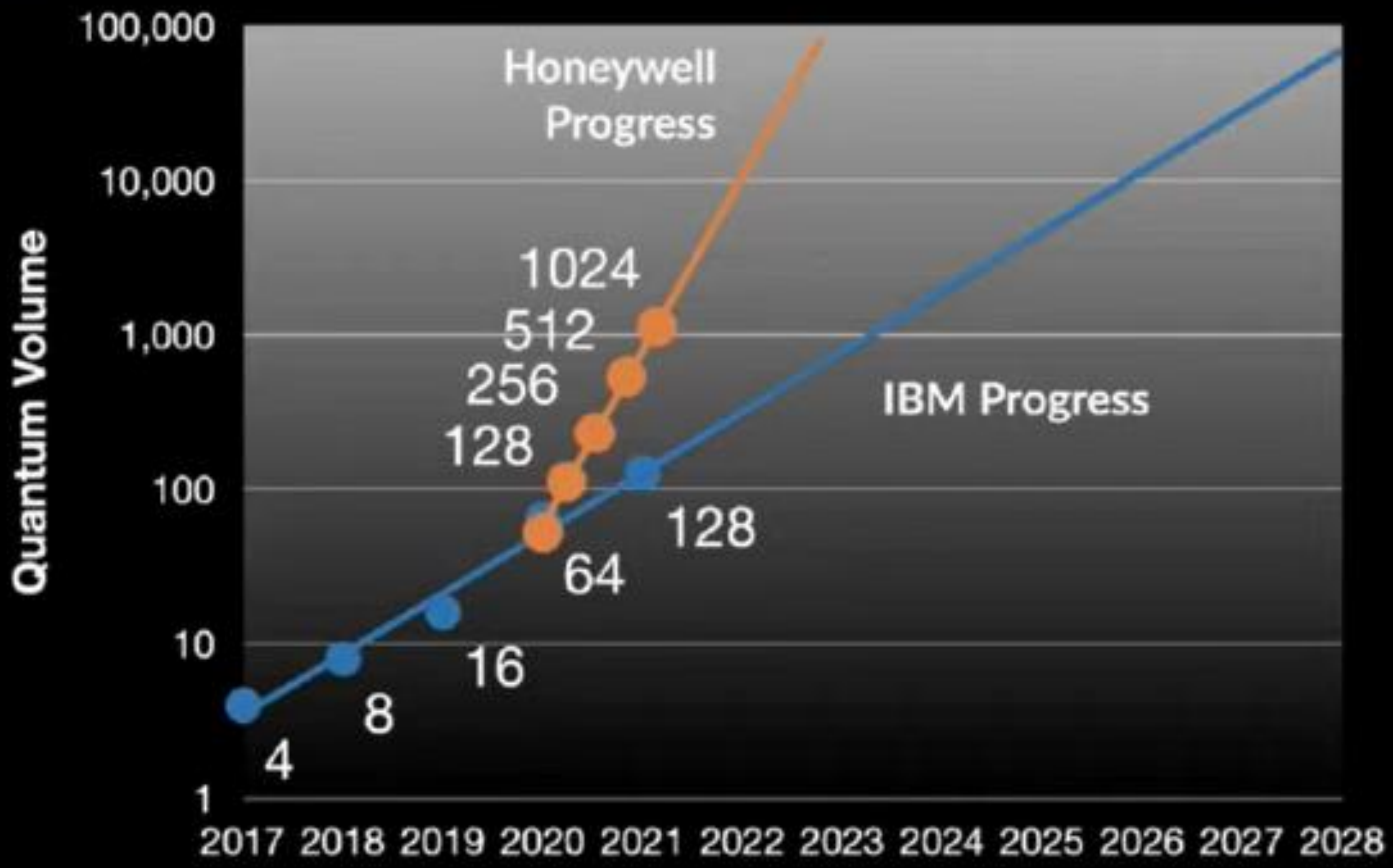
It's official: Google has achieved quantum supremacy

Bravo for Google's 'quantum supremacy.'

COMUNIDAD DARQ
Claudio R. Parrinello


NISQ
(noisy intermediate-scale quantum)
1995: Primera puerta cuántica con iones atrapados (CNOT)
1999: Primer qubit superconductor
2001: Factorización del número 15 usando el algoritmo de Shor
2006: Trampas de iones en 2 dimensiones
2007: Desarrollo del transmon
2009: Simulación molécula de hidrógeno
2014: USCB se une a Google
2015: Fundación IonQ
2016: IBM Q Experience Ordenadores cuánticos en la nube
2017: Integración 3D de qubits superconductores
2019: Supremacía cuántica: Sycamore, Google
2021: Operaciones con tolerancia a errores en iones atrapados
COMUNIDAD DARQ
Claudio R. Parrinello

Roadmap for Quantum Hardware Improvement



Moore's Law implies doubling of classical computing power every ~18 months

IBM believes they can double the 'quantum volume' every year

Honeywell claims they can increase it by a factor of TEN every year, meaning 100,000x improvement by 2025

COMUNIDAD DARQ
Claudio R. Parrinello

Not all Quantum algorithms improve (in speed) a classical algorithm in the same way

Quadratic speed up:

From 16 seconds to 4 seconds

From 17 min to 32 seconds

From 12 days to 17 min

From 34000 years to 12 days

From 30 million years to 1 year

Exponential speed up:

From 16 seconds to 4 seconds

From 17 min to 10 seconds

From 12 days to 20 seconds

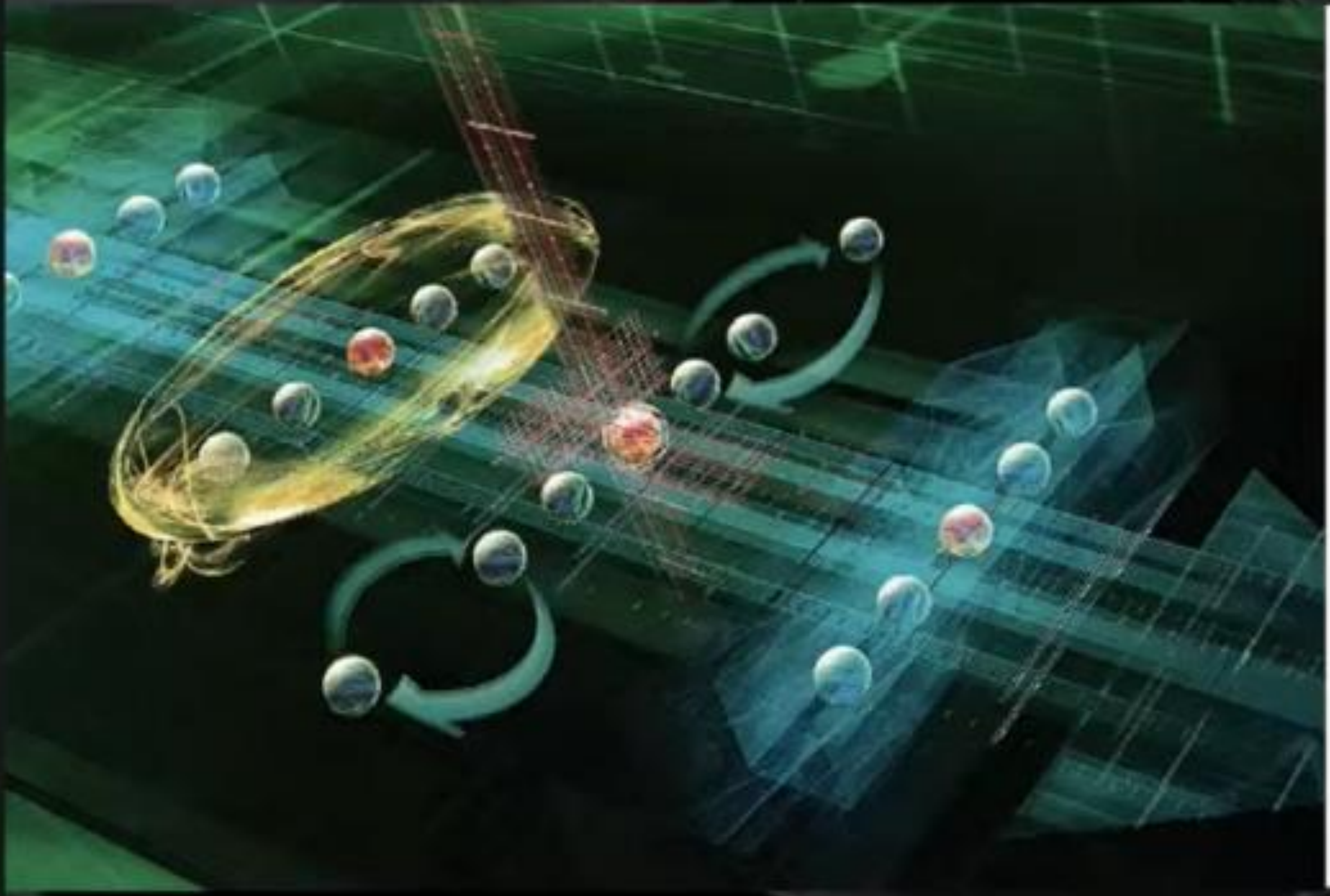
From 34000 years to 40 seconds

From 30 million years to 50 seconds

IBM Google AI Quantum

COMUNIDAD DARQ
Claudio R. Parrinello

Quantum Error Correction



Spreading the information on one qubit amongst many

Amazingly: this can be done without copying quantum data, and without measuring it!

COMUNIDAD DARQ
Claudio R. Parrinello

Noisy Intermediate-Scale Quantum (NISQ)

Definite Constraints:

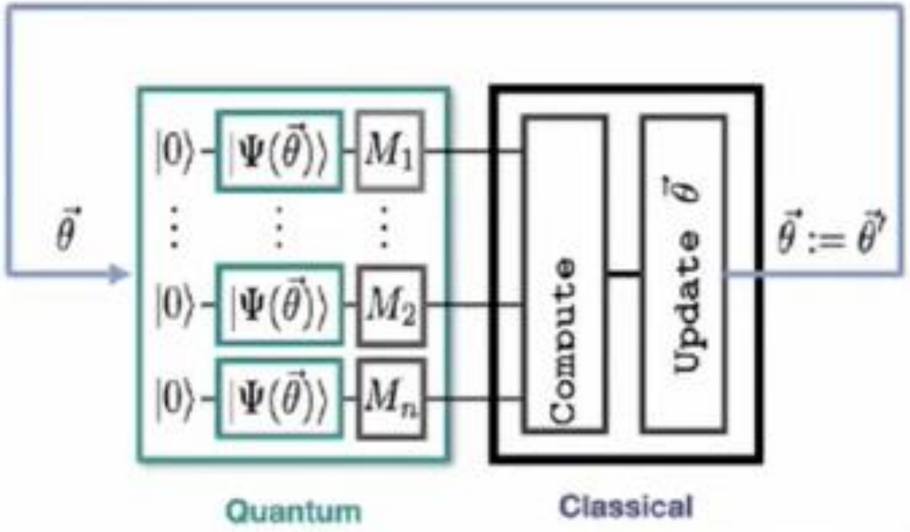
- 50 – 100 qubits
- High error rates
- No error correction

Potential Constraints:

- Connectivity constraints
- Low coherence time

NISQ Algorithms are:

- Hybrid quantum+classical
- Small circuit depth



COMUNIDAD DARQ
Claudio R. Parrinello

Quantum Algorithms

Examples of quantum subroutines with speedups

Method	Speedup
Bayesian inference [24, 25]	$\mathcal{O}(\sqrt{N})$
Online perceptron [26]	$\mathcal{O}(\sqrt{N})$
Least-squares fitting [27]	$\mathcal{O}(\log N)$
Classical Boltzmann machine [28]	$\mathcal{O}(\sqrt{N})$
Quantum Boltzmann machine [29, 30]	$\mathcal{O}(\log N)$
Quantum PCA [22]	$\mathcal{O}(\log N)$
Quantum support vector machine [23]	$\mathcal{O}(\log N)$
Quantum reinforcement learning [31]	$\mathcal{O}(\sqrt{N})$

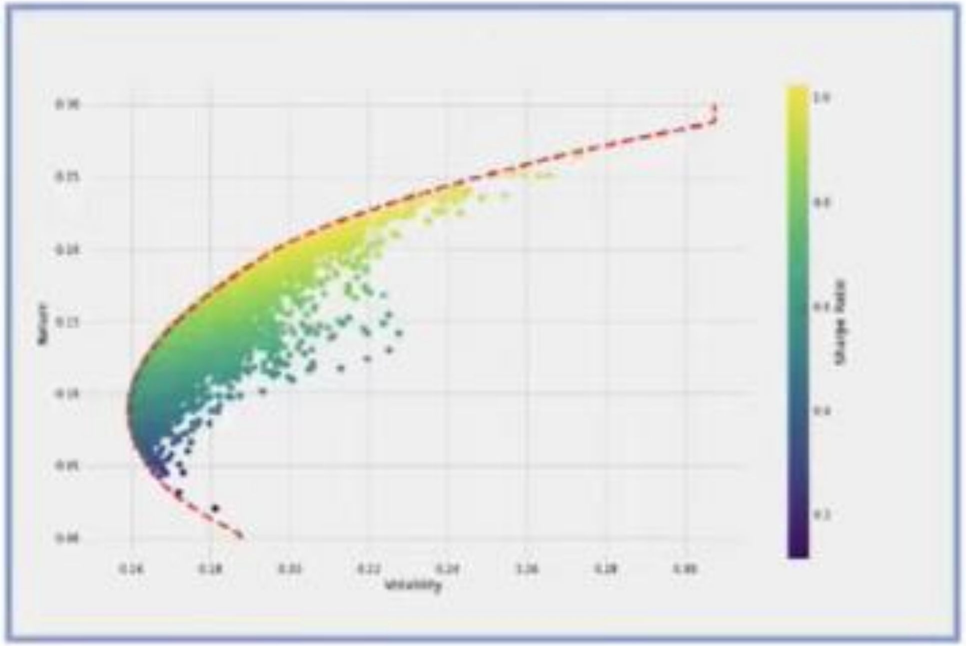
O(√N) is a square-root speed-up, and O(logN) is an exponential speedup

These quantum subroutines for ML require a universal quantum computer with many qubits (not NISQ) and fast I/O (QRAM): longer term

COMUNIDAD DARQ
Claudio R. Parrinello

Quantum Optimization

- Optimization is used in many applications including arbitrage and portfolios
- Semi-Definite Programming (SDP) is a sub-field of convex optimization which minimizes a linear objective function over positive semidefinite matrix inequality constraints
- Quantum SDP (QSDP) is a new and powerful extension of the classical SDP which may be exponentially faster, and uses relatively few qubits and therefore may be amenable to today's NISQ devices



COMUNIDAD DARQ
Claudio R. Parrinello

Fundamentally, there are 4 “families” of algorithms that can be applied to many various business problems

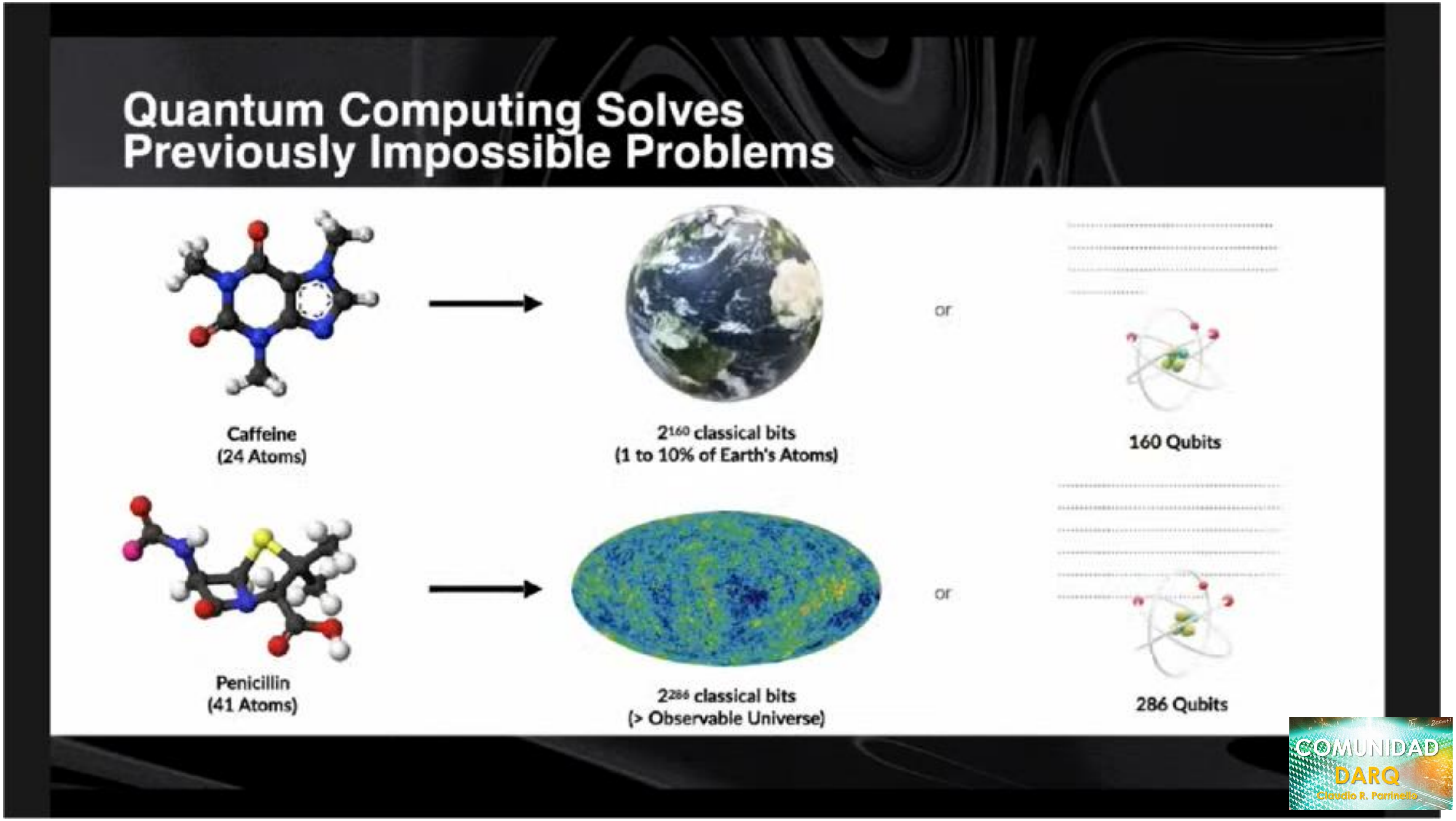
1
Model physical processes of nature

2
Perform significantly more scenario simulations

3
Obtain better optimization solutions

4
Find better patterns within AI/ML processes

COMUNIDAD DARQ
Claudio R. Parrinello


Quantum Computing Solves Previously Impossible Problems
Caffeine
(24 Atoms)
2^{160} classical bits
(1 to 10% of Earth's Atoms)
or
160 Qubits
Penicillin
(41 Atoms)
2^{286} classical bits
(> Observable Universe)
or
286 Qubits
COMUNIDAD
DARQ
Claudio R. Parrinello

Applications of Quantum Computing

Chemistry and Pharma

- Protein Folding
- Drug Discovery
- Bioinformatics
- Catalysts & Fertilizers

Active Pioneers
BASF, Merck, JSR, Biogen, Bayer, DuPont

Industrial Goods

- Logistics: Planning, routing, and distribution
- Traffic optimization
- Chip layout optimization
- Solar cell & OLED development

Active Pioneers
VW, Airbus, BMW, NASA, Bosch, Daimler

Information Technology

- Machine learning (neural networks)
- Database search
- Cybersecurity & crypto

Active Pioneers
IBM, AliBaba, Google, Samsung, Microsoft

Finance

- Trading strategies
- Portfolio optimization
- Asset pricing
- Risk analysis
- Market simulation

Active Pioneers
JP Morgan, Barclays, Goldman Sachs, ING

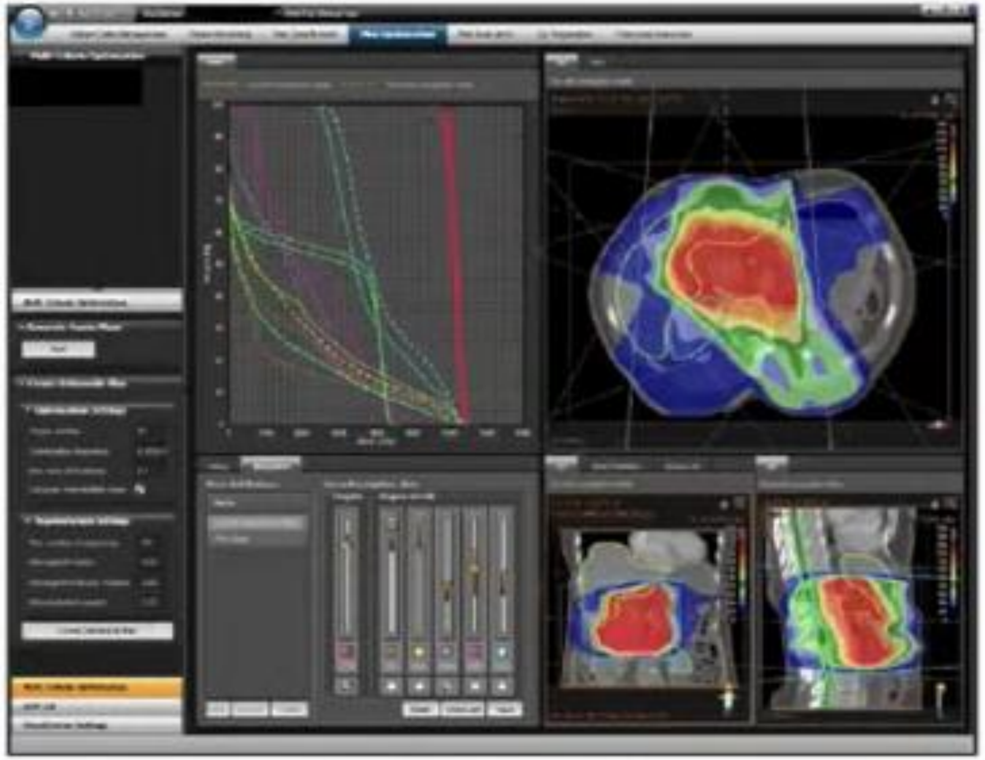
COMUNIDAD DARQ
Claudio R. Parrinello

Radiotherapy

- Radiation therapy is the most widely-used form of treatment for cancers. Radiation beams are used to destroy cancerous cells or at least stop them multiplying

- Devising a radiation plan is to minimize damage to surrounding healthy tissue and body parts is a very complicated optimization problem with thousands of variables

- With a quantum computer, the horizon of possibilities that can be considered between each simulation is much broader



The Potential of Quantum Computing and Machine Learning to Advance Clinical Research and Change the Practice of Medicine, Missouri Medicine, Sept-Oct 2018

COMUNIDAD DARQ
Claudio R. Parrinello

Knapsack Problem

In order to compare classical vs quantum approaches, CQC developed a prototype Knapsack Quantum Algorithm

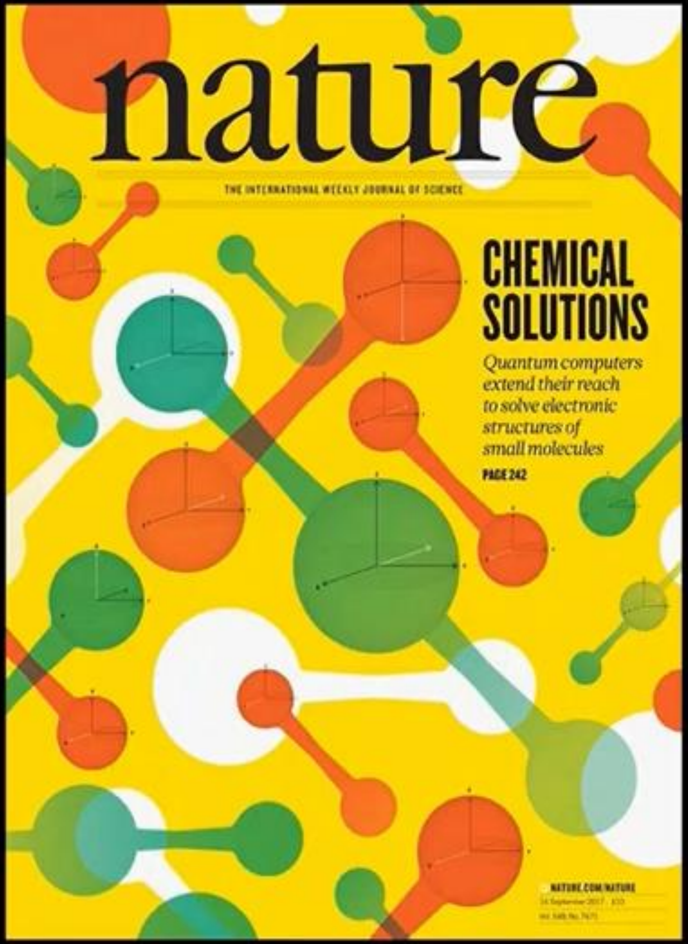
Given a set of items, each with a weight and a value, determine the number of each item to include in a collection so that the total weight is less than or equal to a given limit and the total value is as large as possible

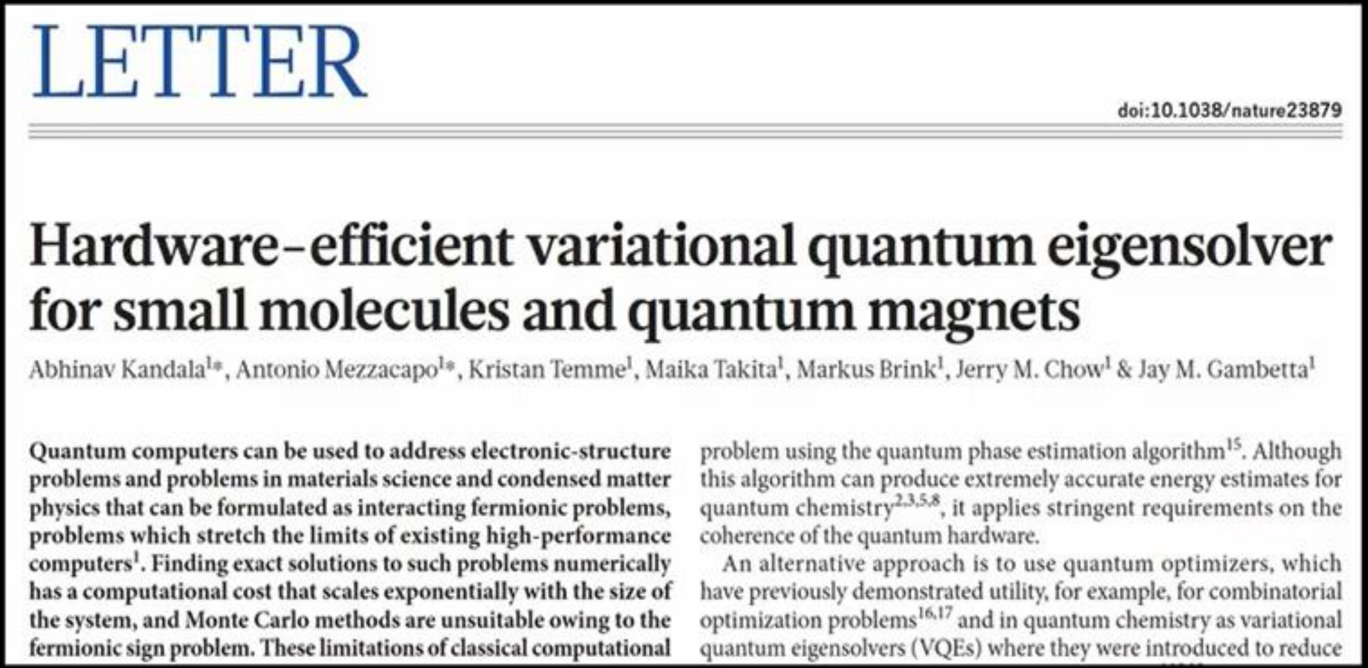
Similar types of (NP hard!) problems are found in:

- Job scheduling
- Physical & Electronic Storage Optimization
- Portfolio optimization
- Cryptography

COMUNIDAD DARQ
Claudio R. Parrinello

First models started to be available already 3 years ago





LETTER

doi:10.1038/nature23879

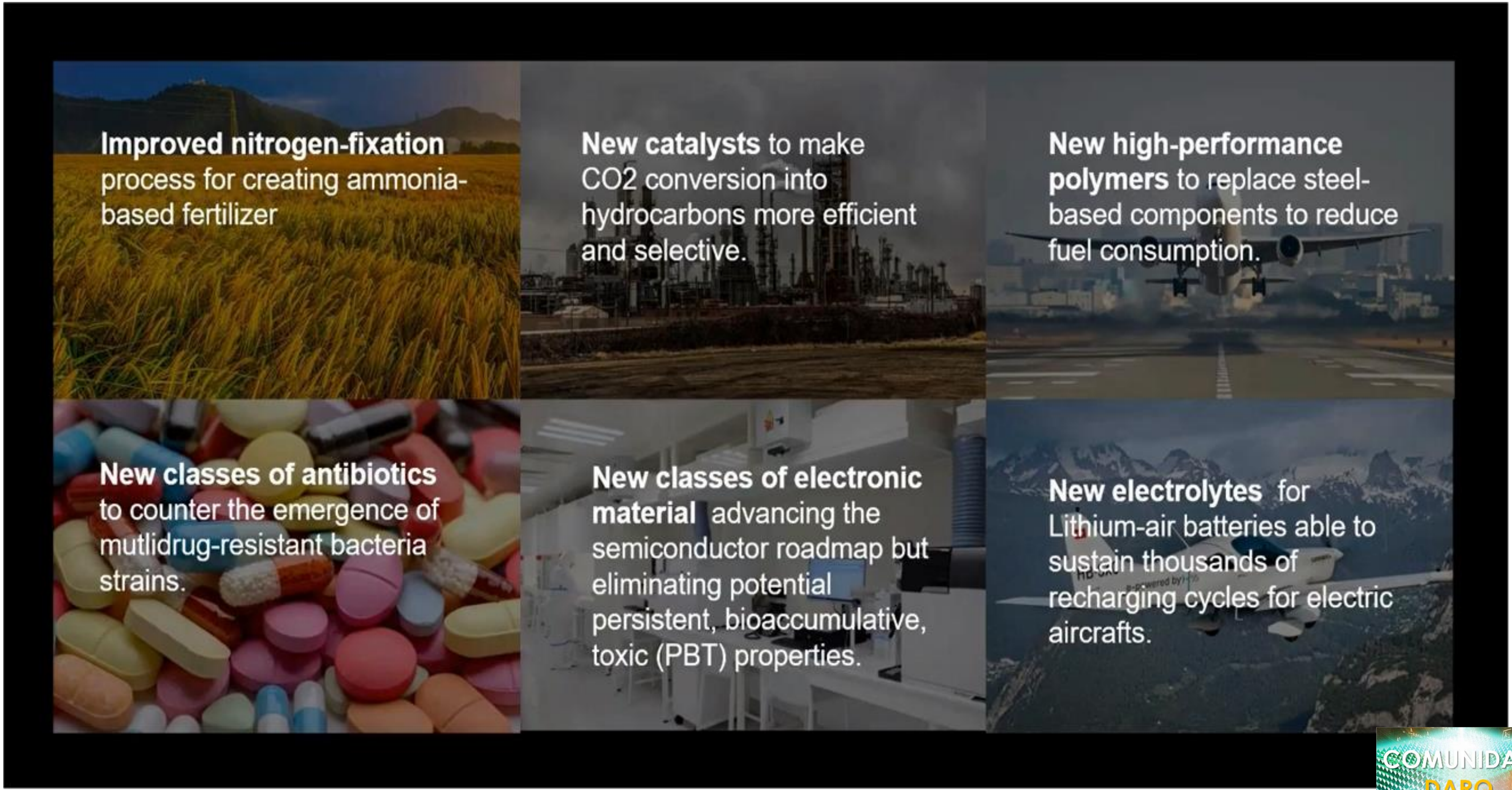
Hardware-efficient variational quantum eigensolver for small molecules and quantum magnets

Abhinav Kandala[1*], Antonio Mezzacapo[1*], Kristan Temme[1], Maika Takita[1], Markus Brink[1], Jerry M. Chow[1] & Jay M. Gambetta[1]

Quantum computers can be used to address electronic-structure problems and problems in materials science and condensed matter physics that can be formulated as interacting fermionic problems, problems which stretch the limits of existing high-performance computers[1]. Finding exact solutions to such problems numerically has a computational cost that scales exponentially with the size of the system, and Monte Carlo methods are unsuitable owing to the fermionic sign problem. These limitations of classical computational problem using the quantum phase estimation algorithm[15]. Although this algorithm can produce extremely accurate energy estimates for quantum chemistry[2,3,5,8], it applies stringent requirements on the coherence of the quantum hardware.

An alternative approach is to use quantum optimizers, which have previously demonstrated utility, for example, for combinatorial optimization problems[16,17] and in quantum chemistry as variational quantum eigensolvers (VQEs) where they were introduced to reduce

Be H_2


Improved nitrogen-fixation process for creating ammonia-based fertilizer
New catalysts to make CO2 conversion into hydrocarbons more efficient and selective.
New high-performance polymers to replace steel-based components to reduce fuel consumption.
New classes of antibiotics to counter the emergence of mutlidrug-resistant bacteria strains.
New classes of electronic material advancing the semiconductor roadmap but eliminating potential persistent, bioaccumulative, toxic (PBT) properties.
New electrolytes for Lithium-air batteries able to sustain thousands of recharging cycles for electric aircrafts.

- Trading Strategies
- Portfolio Optimizations
- Asset pricing
- Risk Analysis
- Fraud Detection
- Market Simulations

AMERICAN BANKER   All Sections

NOW READING: The Latest | Why banks like Barclays are testing quantum computing | Conference Block|FS | Banks team with fintech AI to commercial accou

Why banks like Barclays are testing quantum computing

By
Penny Crosman

Published
July 16 2018, 4:12pm EDT

More in
High performance computing
Bank technology
Barclays
Morgan Stanley
IBM

Print   Reprint

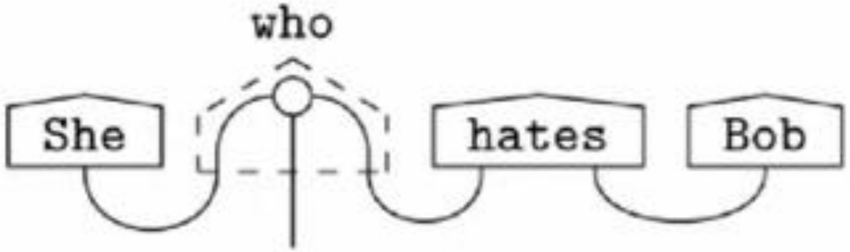
Quantum computing — technology based on the principles of quantum theory — is increasingly attracting the interest of financial services firms that are seeking to process transactions, trades and other types of data as fast as possible.

Barclays and JPMorgan Chase have been experimenting with IBM's quantum computing technology since December, when they joined the tech company's Q network. Salvatore Cucchiara at Morgan Stanley last week articulated the bank's hope of speeding up portfolio optimizations like Monte Carlo simulations with the help of quantum computing.

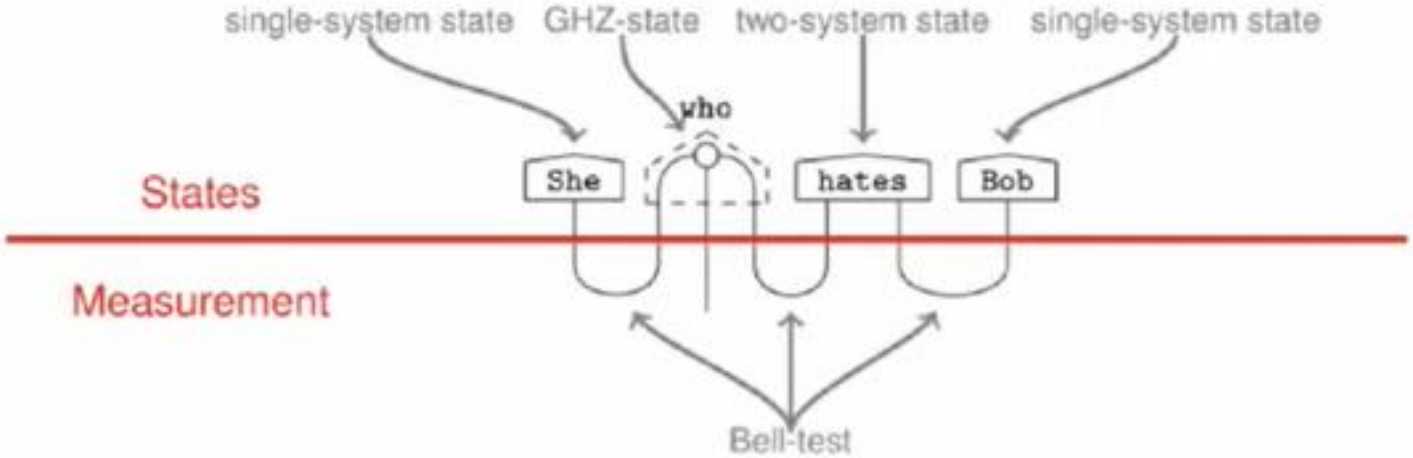
Comunidad DARQ
Claudio R. Parrinello

Quantum Natural Language Processing

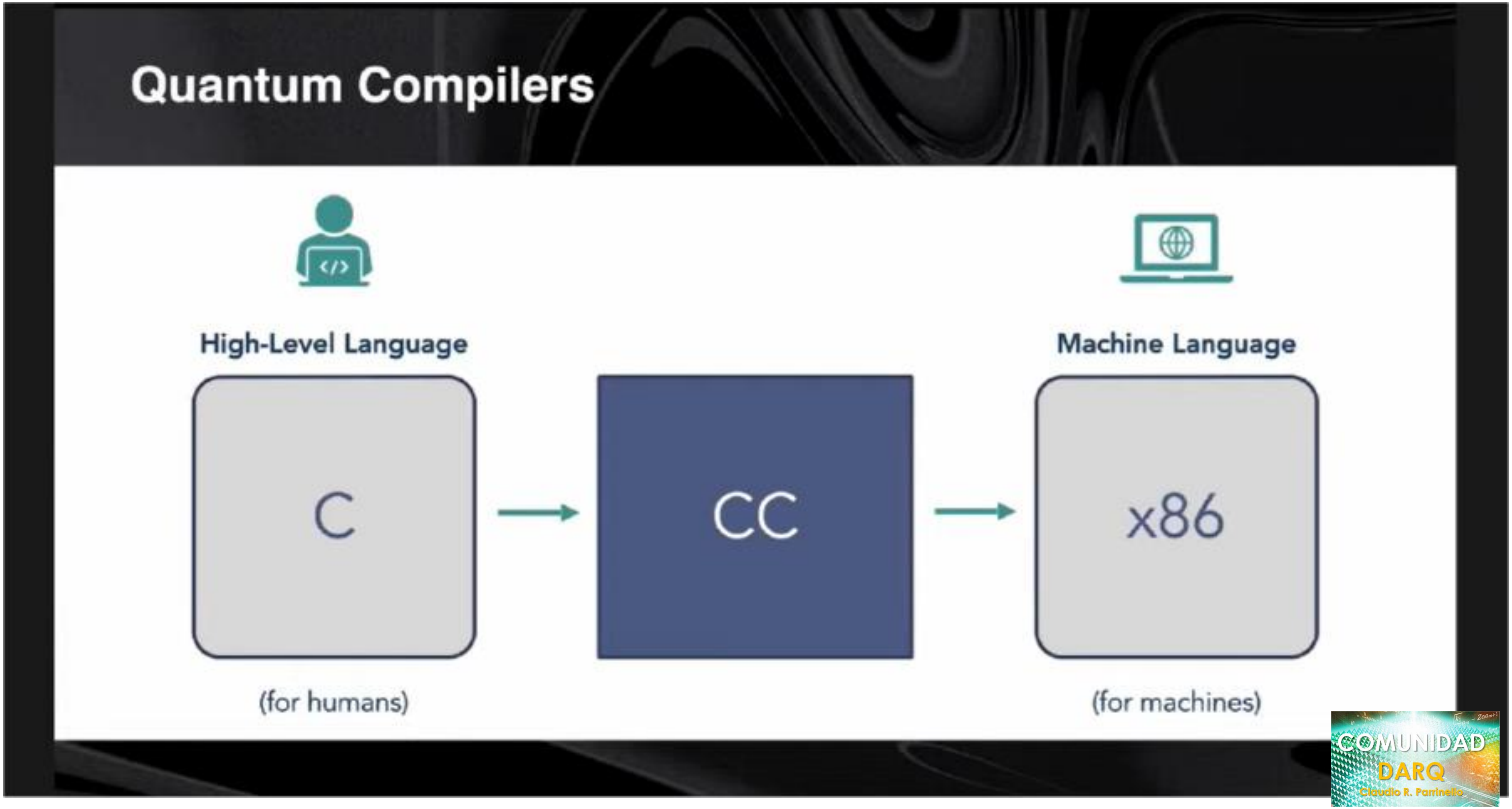
Alexa, Siri, and chatbots use NLP to process "human speak"



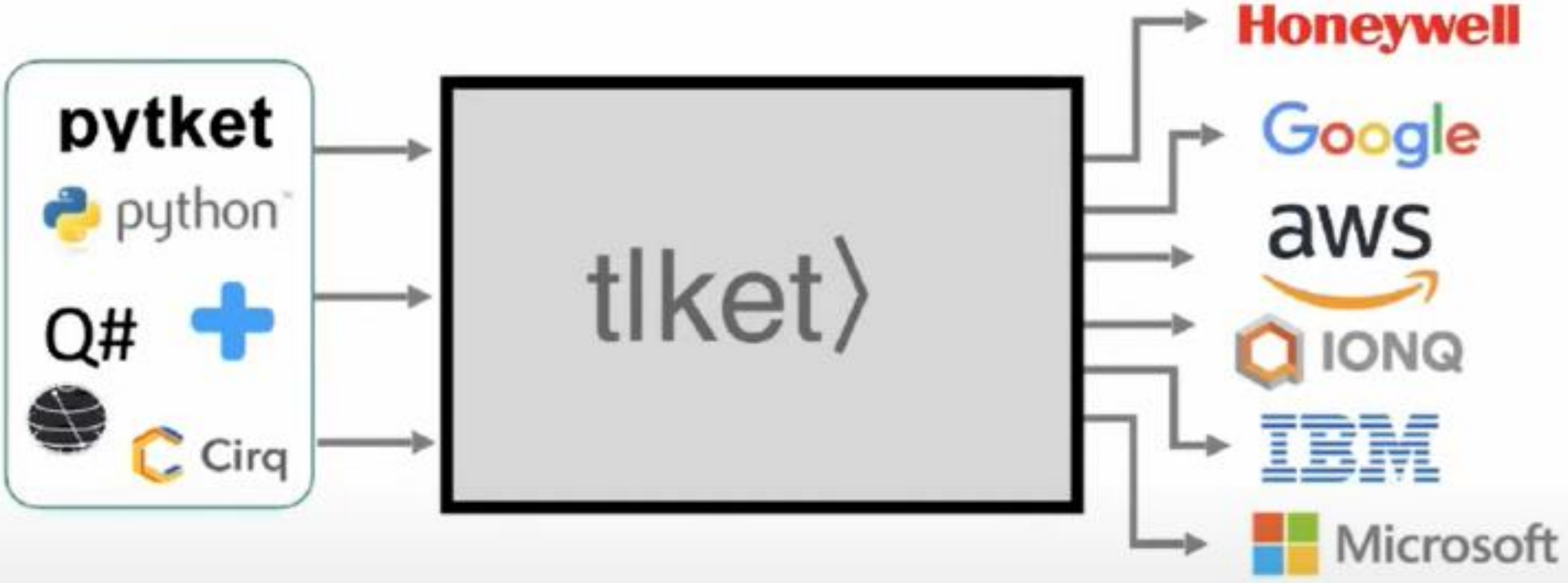
Quantum:



COMUNIDAD DARQ
Claudio R. Parrinello

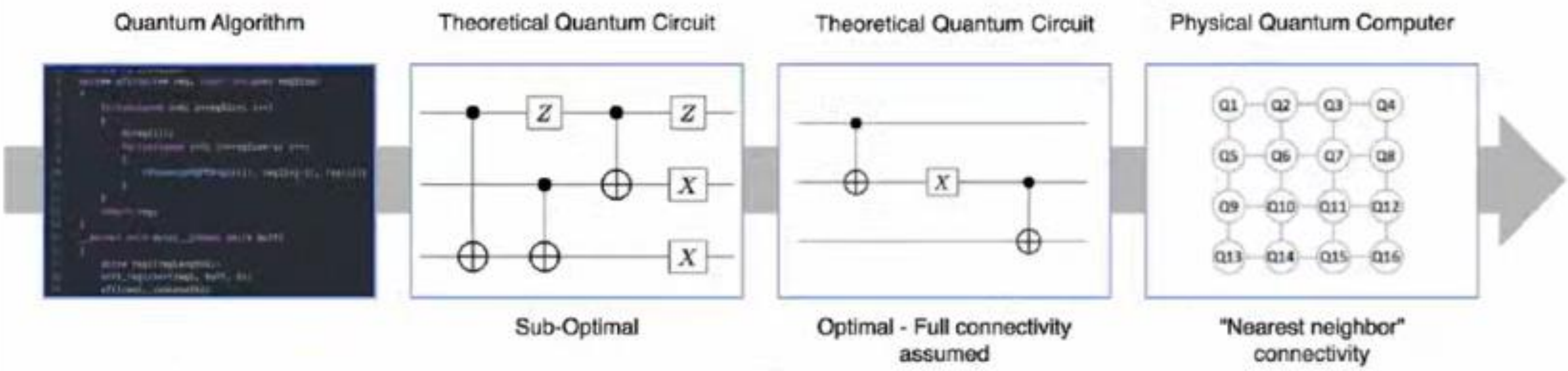

Quantum Compilers
High-Level Language
Machine Language
C
CC
x86
(for humans)
(for machines)
COMUNIDAD
DARQ
Claudio R. Parrinello

Quantum Software: tlket⟩



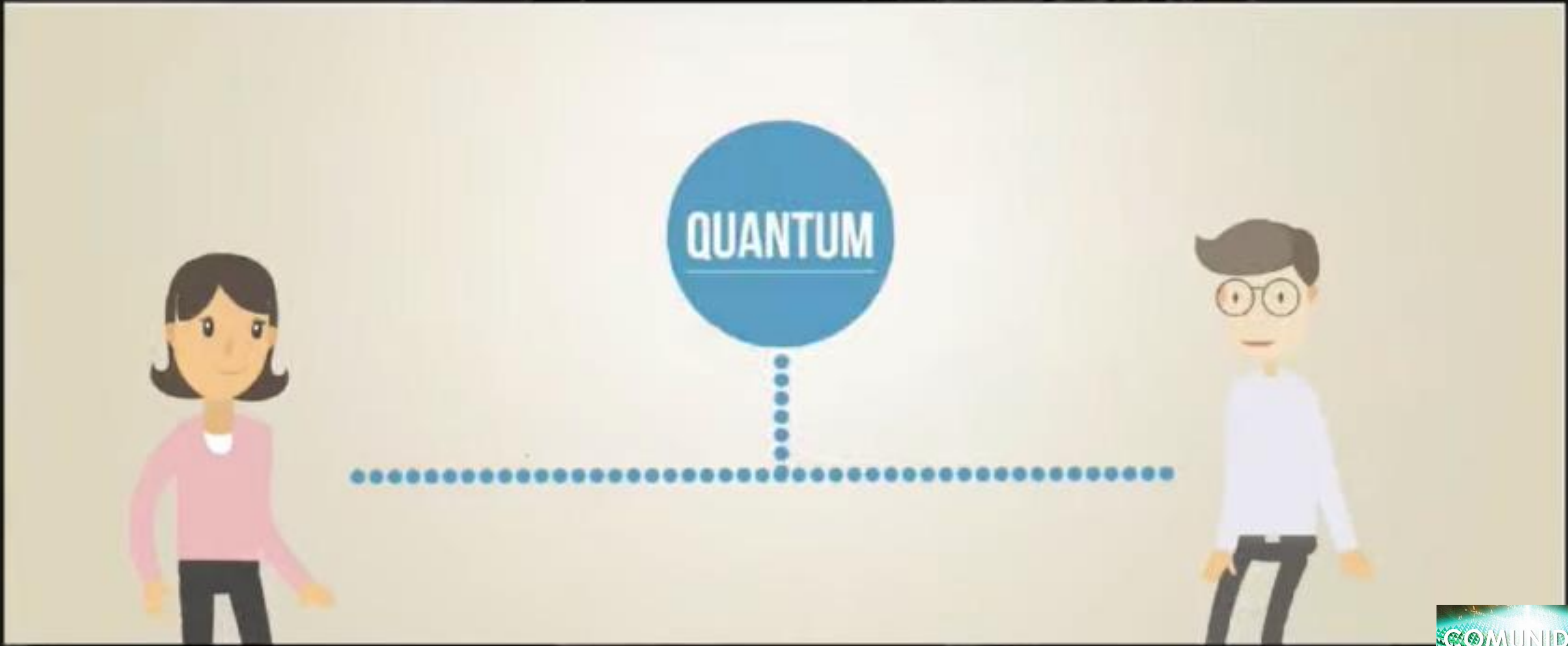
COMUNIDAD DARQ
Claudio R. Parrinello

Quantum Compiler Steps



COMUNIDAD DARQ
Claudio R. Parrinello

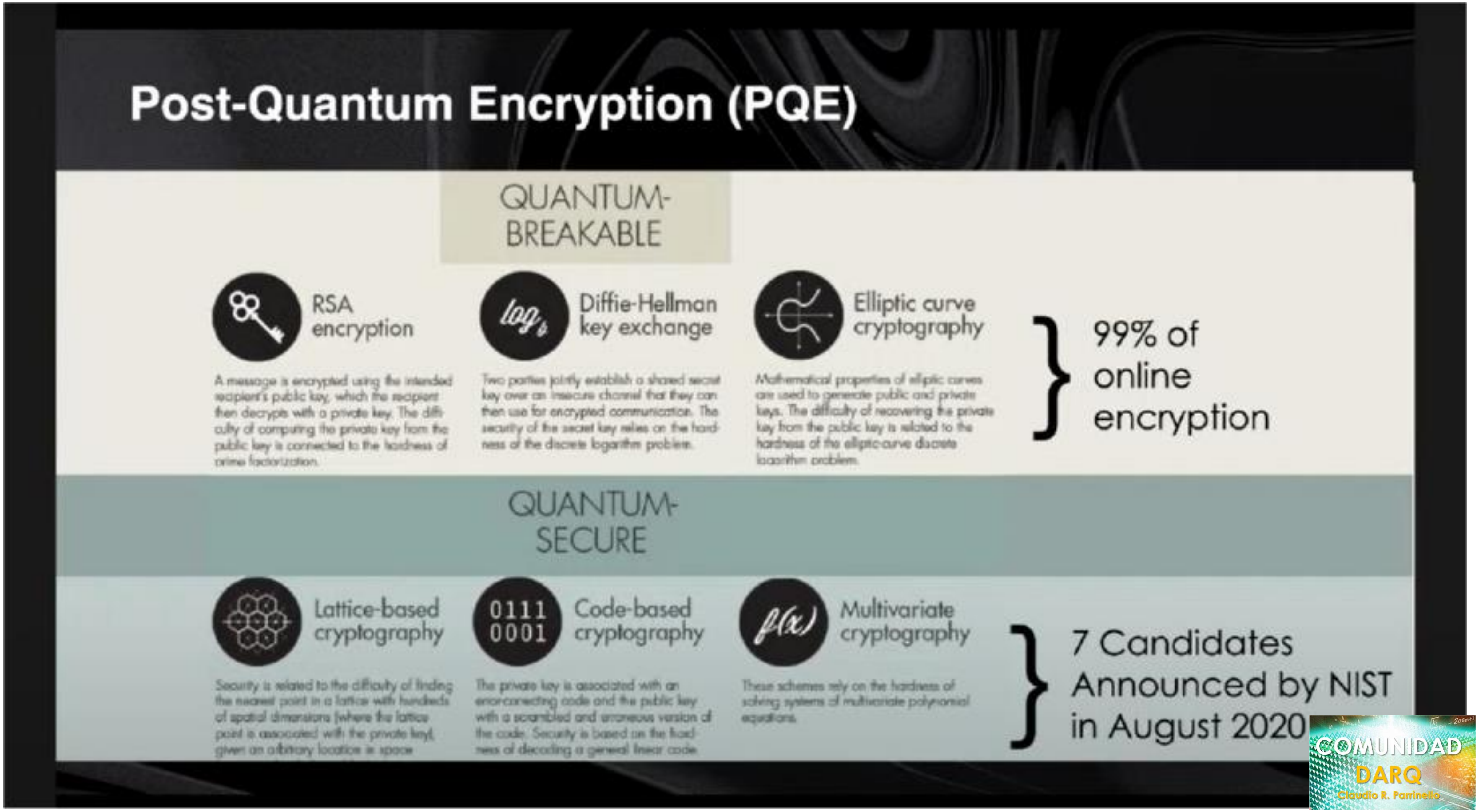
Current Encryption is at Risk



COMUNIDAD
DARQ
Claudio R. Parrinello

How Encryption Works

COMUNIDAD DARQ
Claudio R. Parrinello


Post-Quantum Encryption (PQE)
QUANTUM-BREAKABLE
RSA encryption
A message is encrypted using the intended recipient's public key, which the recipient then decrypts with a private key. The difficulty of computing the private key from the public key is connected to the hardness of prime factorization.
Diffie-Hellman key exchange
Two parties jointly establish a shared secret key over an insecure channel that they can then use for encrypted communication. The security of the secret key relies on the hardness of the discrete logarithm problem.
Elliptic curve cryptography
Mathematical properties of elliptic curves are used to generate public and private keys. The difficulty of recovering the private key from the public key is related to the hardness of the elliptic-curve discrete logarithm problem.
99% of online encryption
QUANTUM-SECURE
Lattice-based cryptography
Security is related to the difficulty of finding the nearest point in a lattice with hundreds of spatial dimensions (where the lattice point is associated with the private key), given an arbitrary location in space
0111
0001
Code-based cryptography
The private key is associated with an error-correcting code and the public key with a scrambled and erroneous version of the code. Security is based on the hardness of decoding a general linear code.
f(x)
Multivariate cryptography
These schemes rely on the hardness of solving systems of multivariate polynomial equations.
7 Candidates Announced by NIST in August 2020
COMUNIDAD DARQ
Claudio R. Parrinello

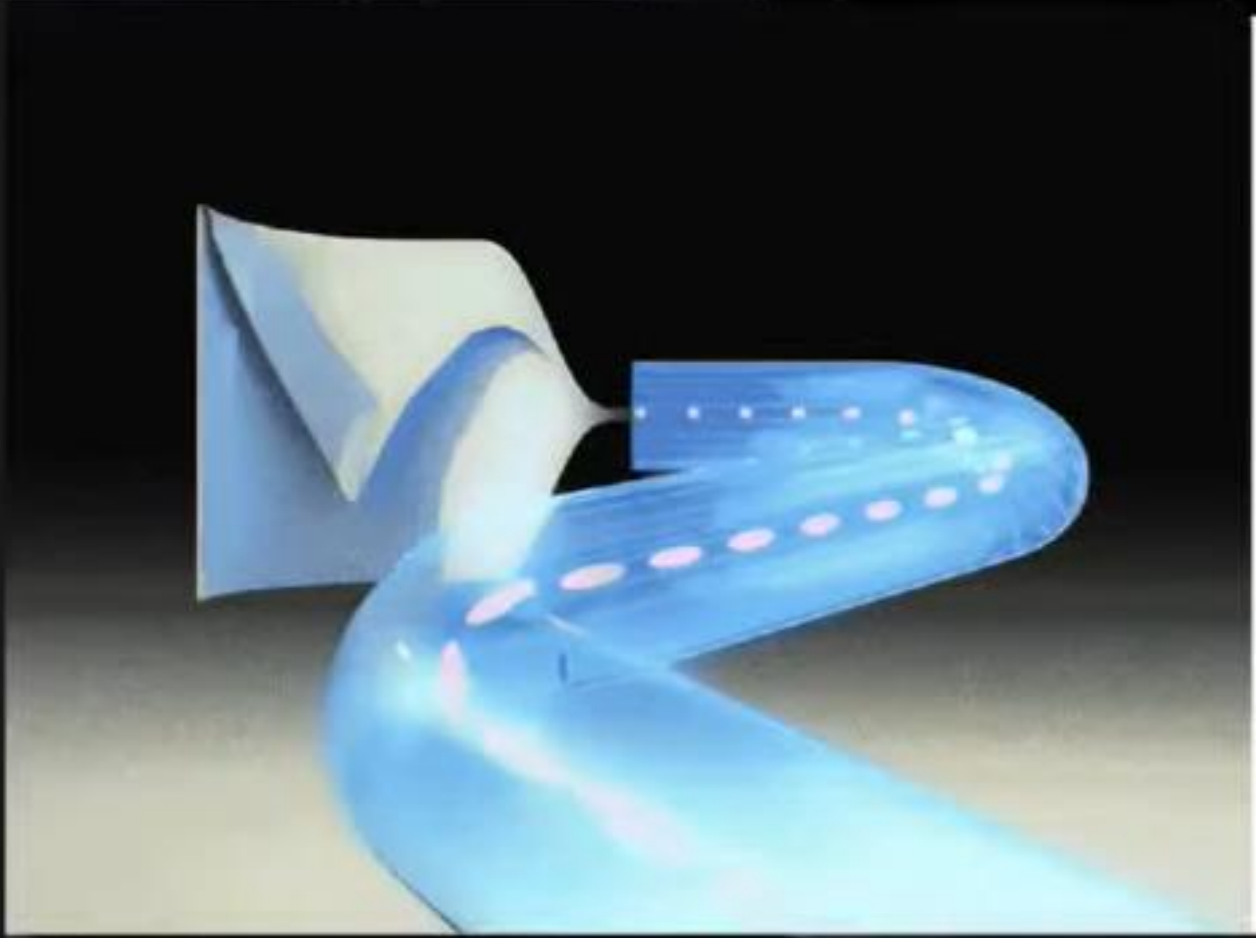
Upgrading to PQE

Good news: There are already 7 "Post-quantum" Encryption Algorithms developed

Bad news: It is believed that upgrading may take 20 years

COMUNIDAD DARQ
Claudio R. Parrinello

Quantum Communication



Quantum Key Distribution transmits quantum data, using fiber optics or satellites.

It is **completely secure**, since eavesdropping changes the quantum state and can be detected.

ILLUSTRATION: BUTT STUDIO FOR BLOOMBERG BUSINESSWEEK

COMUNIDAD DARQ
Claudio R. Parrinello

- Trading Strategies
- Portfolio Optimizations
- Asset pricing
- Risk Analysis
- Fraud Detection
- Market Simulations

COMUNIDAD DARQ
Claudio R. Parrinello

AMERICAN BANKER

Why banks like Barclays are testing quantum computing

By
Penny Crosman

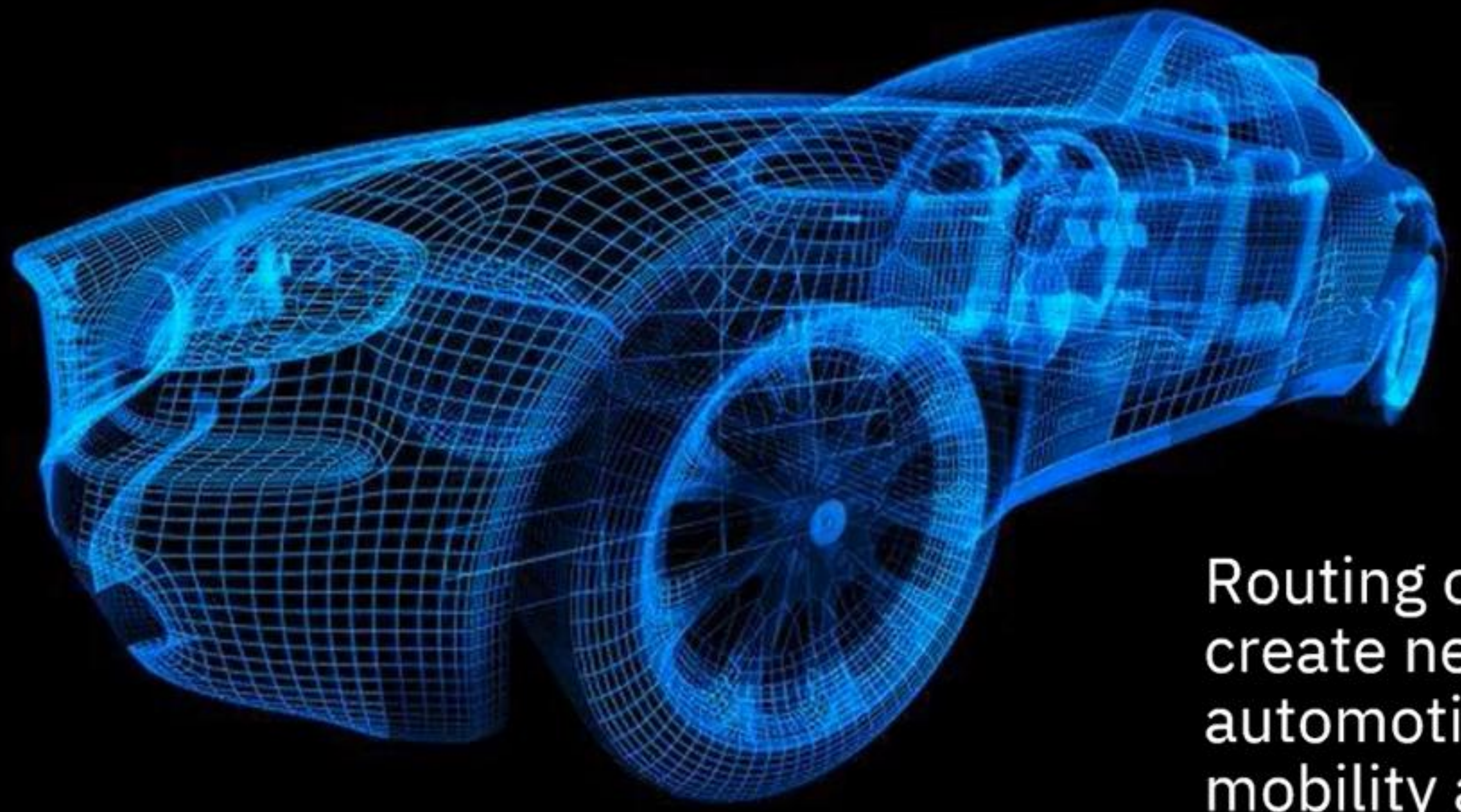
Published
July 16 2018, 4:12pm EDT

More in
High performance computing
Bank technology
Barclays
Morgan Stanley
IBM

Quantum computing — technology based on the principles of quantum theory — is increasingly attracting the interest of financial services firms that are seeking to process transactions, trades and other types of data as fast as possible.

Barclays and JPMorgan Chase have been experimenting with IBM's quantum computing technology since December, when they joined the tech company's Q network. Salvatore Cucchiara at Morgan Stanley last week articulated the bank's hope of speeding up portfolio optimizations like Monte Carlo simulations with the help of quantum computing.

New paths for transportation



Routing optimization to create new products in automotive, such as mobility as a service

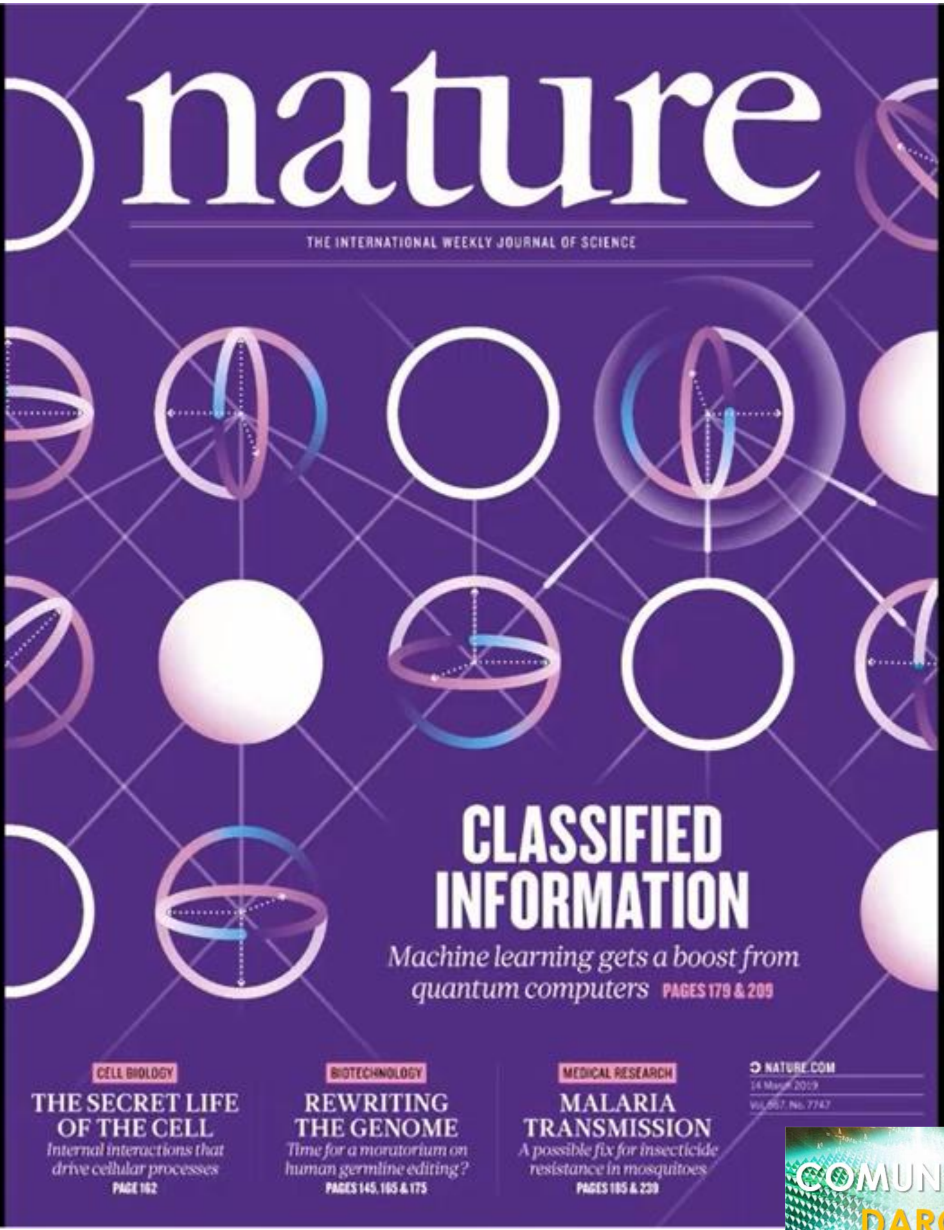
COMUNIDAD DARQ
Claudio R. Parrinello

Qroom cuantic

Quantum Support Vector Machine algorithms are the first ones to provide practical advantage, others will likely follow soon

IBM Q

Google AI Quantum



COMUNIDAD DARQ
Claudio R. Parrinello

Quantum Computing Service

The platform enabling researchers to access beyond-classical computational resources

We are advancing the state of the art in quantum algorithms and applications by granting access to Google's quantum computing hardware. With the Quantum Computing Service, researchers with approved projects can run quantum programs remotely on Google's latest quantum processors like Sycamore with 50+ qubits.

See datasheet | Read the docs

```
import cirq
import sympy

sampler = cirq.google.get_engine_sampler(
    project_id=PROJECT_ID,
    processor_id=PROCESSOR_ID,
    gate_set_name='sqrt_iswap')

circuit = cirq.Circuit(
  cirq.XPowGate(exponent=sympy.Symbol('t'))(cirq.GridQubit(5,4)),
  cirq.measure(cirq.GridQubit(5,4), key='meas'))
rabi_sweep = cirq.Linspace('t', start=0, stop=1, length=20)

results = sampler.run_sweep(circuit,
  repetitions=1000,params=rabi_sweep)
for t in range(20):
  print(results[t].histogram(key='meas'))
```

COMUNIDAD DARQ
Claudio R. Parrinello

Our software and hardware are specifically designed for building novel quantum algorithms to help solve near-term applications for practical problems.

Learn more

FRAMEWORK

Cirq

Cirq is a Python library for writing, manipulating, and optimizing quantum circuits and running them against quantum computers and simulators.

Learn more

LIBRARY

OpenFermion

An open source library for compiling and analyzing quantum algorithms to simulate fermionic systems, including quantum chemistry.

Learn more

LIBRARY

TensorFlow Quantum

An open source library for hybrid quantum-classical machine learning.

Learn more

Escribe aquí para buscar
18°C ESP

Introducción al kit de desarrollo de Quantum (QDK) para computación cuántica

01/02/2021 • Tiempo de lectura: 4 minutos •

El kit de desarrollo de Microsoft Quantum contiene todas las herramientas que necesitará para compilar sus propios programas y experimentos cuánticos con Q#, un lenguaje de programación diseñado específicamente para el desarrollo de aplicaciones cuánticas.

Para comenzar enseguida, vaya a la guía de configuración del QDK. Allí se le guiará por la configuración del kit de desarrollo de Microsoft Quantum en máquinas Windows, Linux o MacOS para que pueda escribir sus propios programas cuánticos.

Si no está familiarizado con la computación cuántica, revise la sección Información general para más información sobre qué pueden hacer los equipos cuánticos y los aspectos básicos de la informática cuántica.

https://docs.microsoft.com/es-es/azure/quantum/install-get-started-qdk

Introducción a la programación con Q#

¿Le ha resultado útil esta página?

Yes No

En este artículo

- Introducción a la programación con Q#
- Más información
- Conceptos clave de la computación cuántica
- Documentación del kit de desarrollo de Microsoft Quantum
- Forme parte de la comunidad de código abierto de Q#

IBM Quantum System One

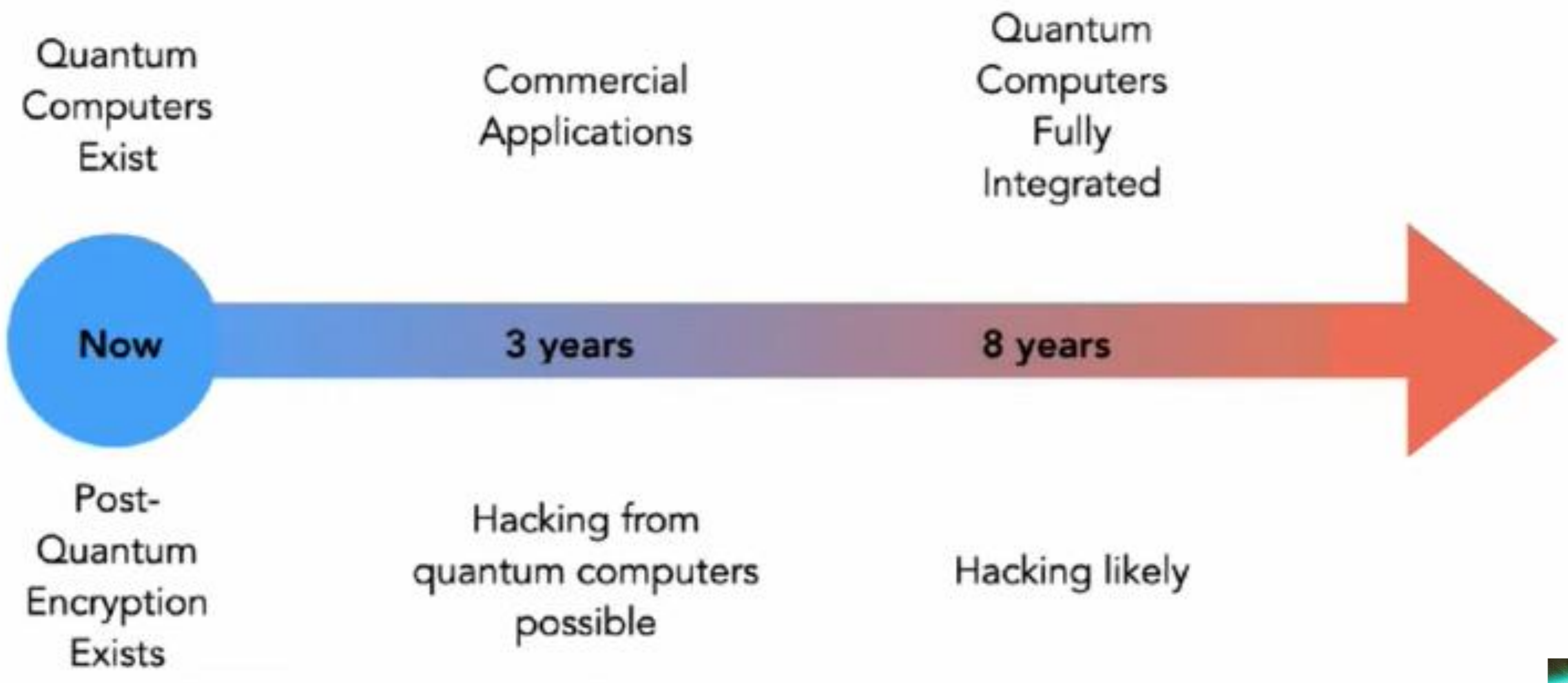
This is the apex of the IBM Quantum offering. Created at the frontiers of multiple emerging technologies, IBM Quantum System One is the world's first integrated product for clients that require an on-site quantum computer system for their exclusive use.

IBM Quantum System One comes with our 27 qubit Falcon processor, demonstrating a quantum volume of 32. The system is upgradeable to our 65 qubit Hummingbird processor and 127 qubit Eagle processor when they become available in late 2023.

Discover IBM Quantum System One →

Contact us →

Conclusion and Forecast



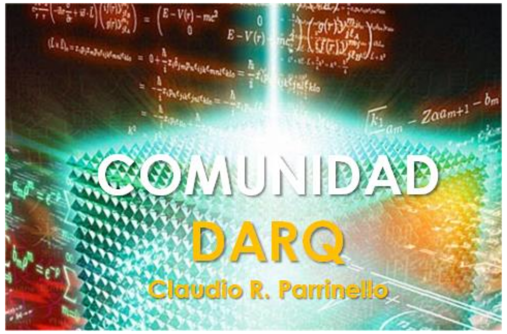
COMUNIDAD DARQ
Claudio R. Parrinello

Científicos chinos han desvelado la primera red de comunicación cuántica integrada que está hecha de 700 fibras ópticas, extendidas a lo largo de 2.000 kilómetros entre Pekín y Shanghái, y tiene dos enlaces con el satélite cuántico Micius, que conectan Xinglong y Nanshan, separados por 2.600 kilómetros.

COMUNIDAD
DARQ
Claudio R. Parrinello

www cuántica sin conexiones basada en teletrasportación de información comunicación instantánea sin conexión.

DARQ: SABER UNA DE LAS TECNOLOGÍAS ES DOMINAR EL PRESENTE SABER LAS 4 ES DOMINAR EL FUTURO



Claudio R. Parrinello
Claudio.Parrinello@guerrerosdandovida.org
Claudio.Parrinello@guardiana.tech