Quantum Computing Timing for Practicality

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Quantum computers **will solve today's impossible problems**. Certain problems intractable on classical computers will be unlocked.

CHEMISTRY	OPTIMIZATION	ARTIFICIAL INTELLIGENCE
J.J.S.		

ADDING QUANTUM POWERS TO COMPUTING



CLASSICAL COMPUTER

CLASSICAL COMPUTER FACTORING A 2048-BIT NUMBER:

• Best **classical** algorithm:

• On a classical **THz** Computer (with a **trillion** operations per second):

QUANTUM COMPUTER

QUANTUM COMPUTER FACTORING A 2048-BIT NUMBER:

• Shor's **quantum** algorithm:

On a quantum MHz computer* (with a million operations per second):

We expect significant breakthroughs in:

OPTIMIZATION

Optimized financial portfolio & global supply chain management

MACHINE LEARNING

Artificial intelligence & predictive maintenance

CHEMISTRY

Accelerated drug discovery & Material science



ADDING QUANTUM POWERS TO COMPUTING

Comparing Classical Computers with Quantum Computers

		Classical Computer	Quantum Computer	
Component	Information unit:	Bit	Quantum bit	
	Info storage:	Transistors	Superconductors/lons	
	Info processing:	Logical gates	Quantum gates	
	Information unit equivalent:	2-sided O	Location on a ball	
	Units working together:	No coordination	Entanglement	



FUNDAMENTAL DIFFERENCES

Comparing Classical Computers with Quantum Computers



Quantum computing power doubles with each additional qubit!

- 30 qubit error corrected QC is more powerful than the largest supercomputers
- Approx. 150-200 qubits is equal to the power of <u>all</u> the computers on earth
- 2³⁰⁰ is larger than the number of atoms in the visible universe*

IT DOESN'T TAKE MANY QUBITS TO BE BIG IN QUANTUM COMPUTING!

Note: IBM has committed to doubling quantum volume every year, having hundreds of qubits is not far away



IBM Unveils World's First Integrated Quantum Computing System for Commercial Use IBM to Open Quantum Computation Center for Commercial Clients in Poughkeepsie, NY

IBM Preps 53-Qubit Quantum Computer for Launch in October



By Joel Hruska on Septe

A NECKLACE OF IONS -

String of ions may out-compute best quantum computers

New ion-based quantum computer debuts by computing the ground state of water.



What Google's Quantum Supremacy Claim Means for Quantum Computing

Leaked details about Google's quantum supremacy experiment stirred up a media frenzy about the next quantum computing milestone

QUANTUM ALGORITHM APPLICATIONS



Pharma – immediate and future

# qubits	Chemistry Simulation (VQE)	Optimization (QAOA)	Quantum Machine Learning
NEAR TERM	Solid state energy calculations	Quadratic (un)constrained binary optimization	Quantum Boltzman machines for generative models
	Reaction path prediction	Heuristics for job shop scheduling problem	Forecasting component demand with supervised machine learning
	Fracture simulation	Heuristics for traveling salesman	Data classification with variational circuits
LONG TERM	Molecular docking simulation	Graph theory problems applied to protein protein interaction networks	Anomaly detection with adversarial neural networks

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Thank You!

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