CALL TO ACTION

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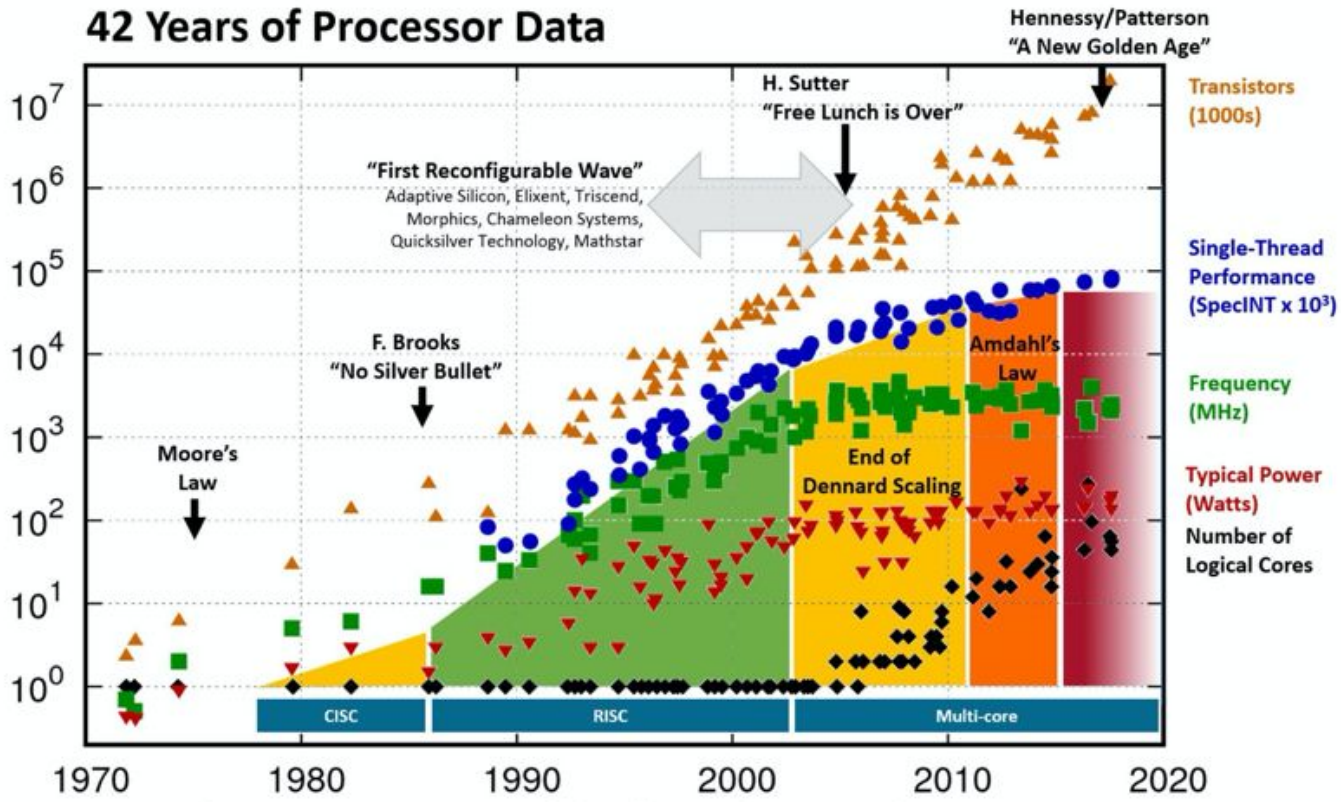
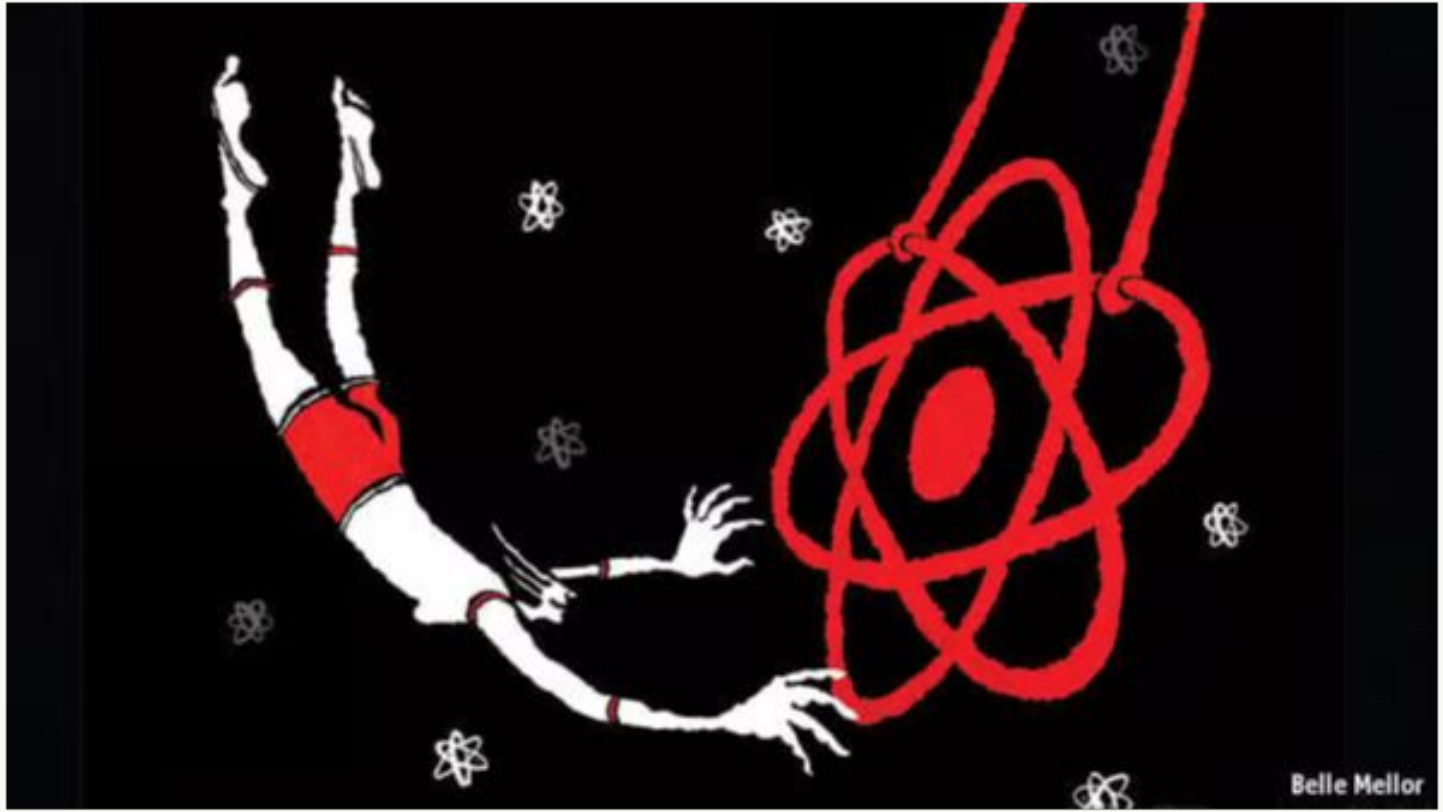
SIAM Quantum Intersections Convening
DMS 2425995

Margaret Martonosi, NSF (2022)

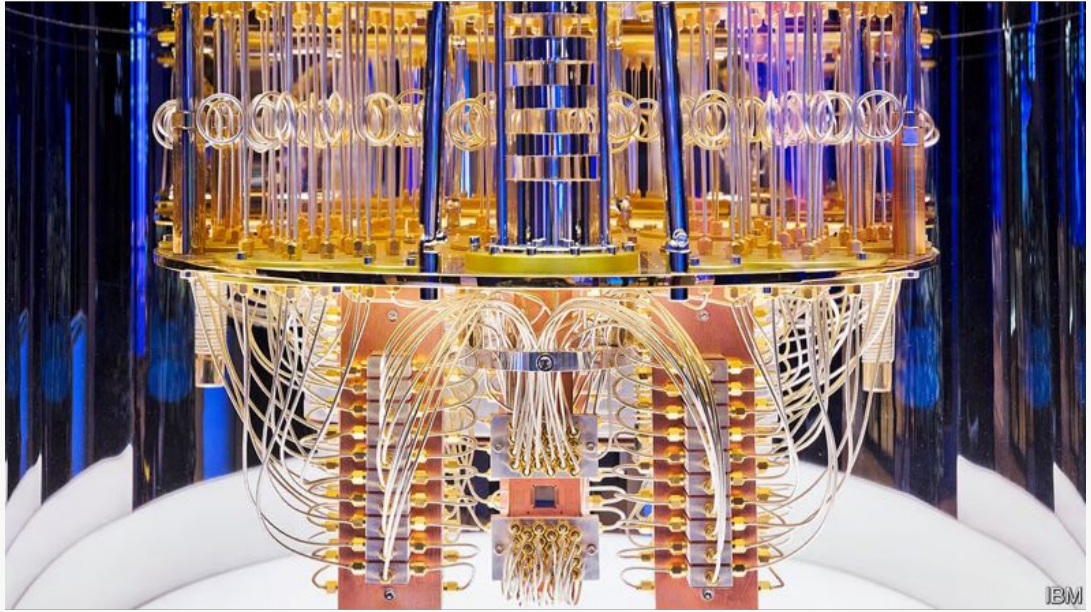
Need for New Computer Processors



Hennessy and Patterson, Turing Lecture 2018, overlaid over "42 Years of Processors Data"
https://www.karlrupp.net/2018/02/42-years-of-microprocessor-trend-data/;"First Wave" added by Les Wilson, Frank Schirrmeister
Original data up to the year 2010 collected and plotted by M. Horowitz, F. Labonte, O. Shacham, K. Olukotun, L. Hammond, and C. Batten
New plot and data collected for 2010-2017 by K. Rupp



A Quantum Leap, Economist, March 2017

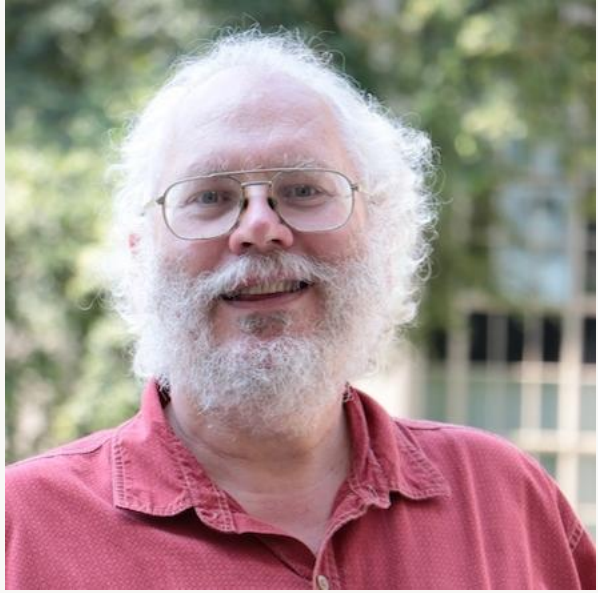


Compute with electrons, photons, atoms; entities that obey the laws of quantum mechanics. Fundamentally different from classical computing.

Beginnings …

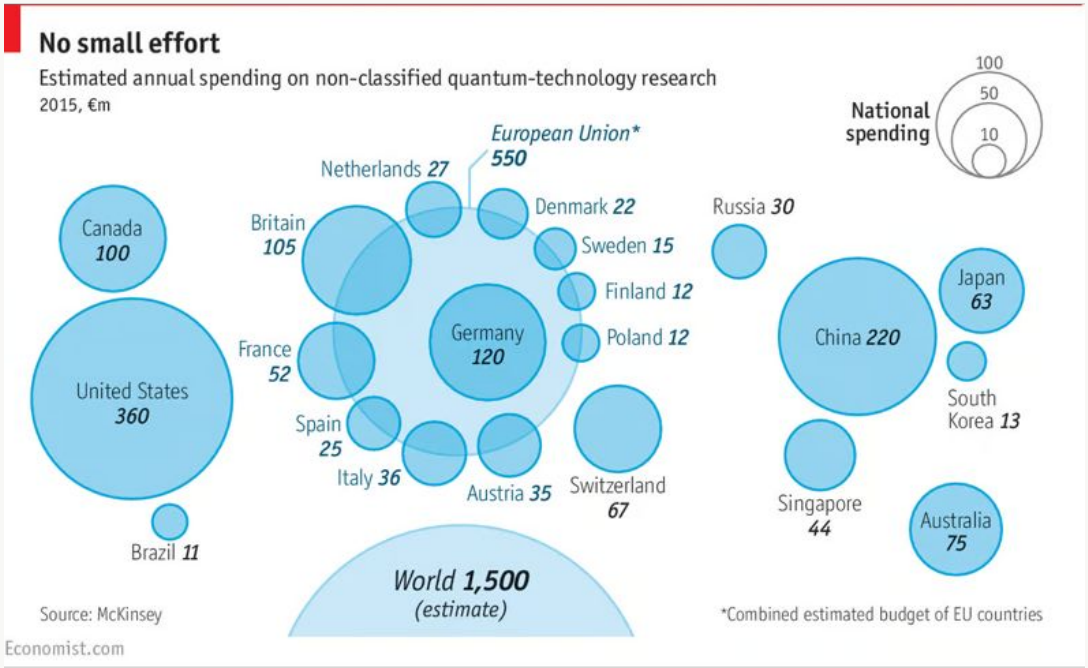
- **Paul Benioff (Argonne), Richard Feynman (1981) Quantum computers could better model quantum phenomena.**
- **Brief history of quantum computing, Edd Gent, livescience.com, Sep. 2024**

Quantum Algorithms



- **Peter Shor, 1994: Quantum algorithm for factoring numbers into primes.**
- **Widely used cryptographic protocols are based on the hardness of factoring large numbers using classical computers.**
- **Shor's algorithm could be used to break these protocols when quantum computers become sufficiently powerful.**

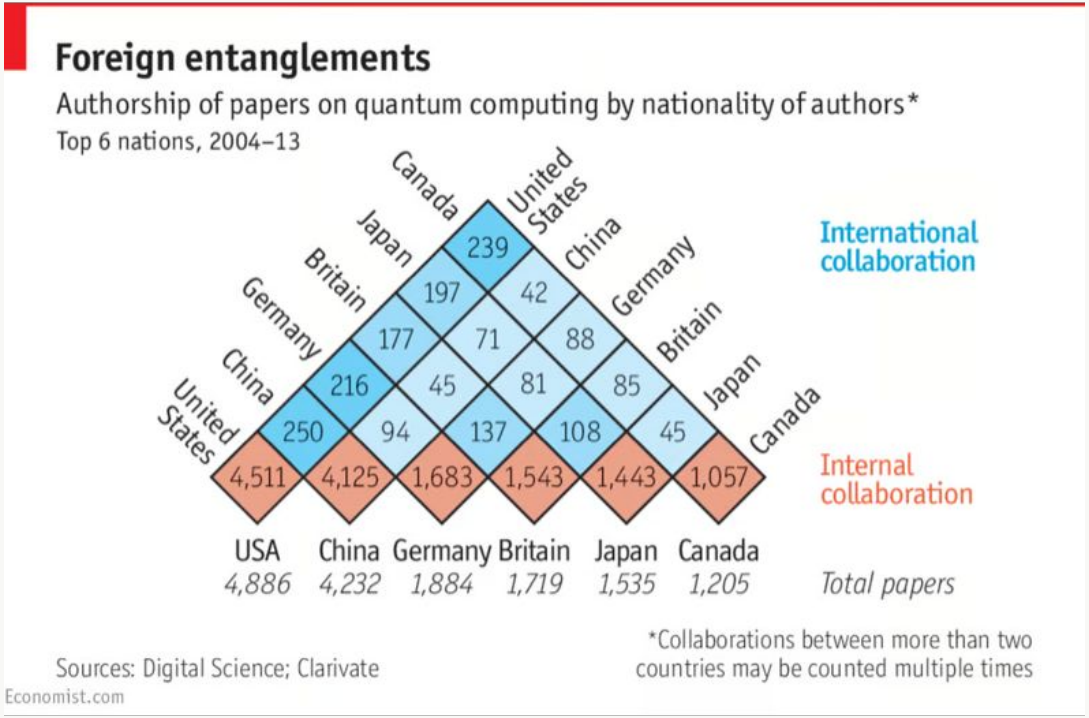
Research Investments



IBM, Google,
Microsoft, Rigetti,
D-Wave
IonQ, QuEra,
Xanadu, …

- **Applications: Volkswagen, Daimler, Airbus, Pharma, Financials, …**

Quantum Publications



Publications

Top 6 countries, 2004-2013

Who is gathered here?

- **Participants**
  - Trained in Applied Mathematics, Computer Science, Physics, Chemistry, Engineering, …
  - Universities, National Labs, Industry
  - Quantum experts, Q-curious, Q-agnostic, …
- **Everyone brings different skills, perspectives, and ideas**
  - Mathematical and Computational Sciences
  - Domain Sciences, Application needs
  - Computer systems, Software design
  - Educational specialists

The big questions: Research

1. How might applied mathematics advance quantum technologies through novel approaches not considered so far?

2. How might research in quantum technologies enrich applied mathematics by bringing new problems and ideas?

The big questions: Workforce

1. How do we create an innovative, diverse workforce that can bring mathematical ideas to multidisciplinary research in quantum technologies?

2. How can we lower the knowledge barrier so more mathematicians can participate in quantum technologies?

The big questions: Partnerships

1. How could mathematicians participate in partnerships involving academia, National Labs and industry, to advance quantum technologies?

What will we accomplish?

- Make more mathematical scientists aware of the demand for their expertise in quantum research and articulating areas and problems where they can contribute
- Increase the participation of researchers in mathematical sciences in the quantum technologies revolution to accelerate its research and development
- Provide a seeding ground for partnerships and collaborations of mathematical scientists with physicists, computer scientists, and engineers from industry and academia, and National Labs

What will we accomplish?

- Goal: recommendations to federal research and development agencies towards support of research and education

- Provide a report for other applied mathematicians to be better informed about quantum computing, and to get involved in research.


LET'S GET TO WORK!

Figure Credits

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