Quantum Computers

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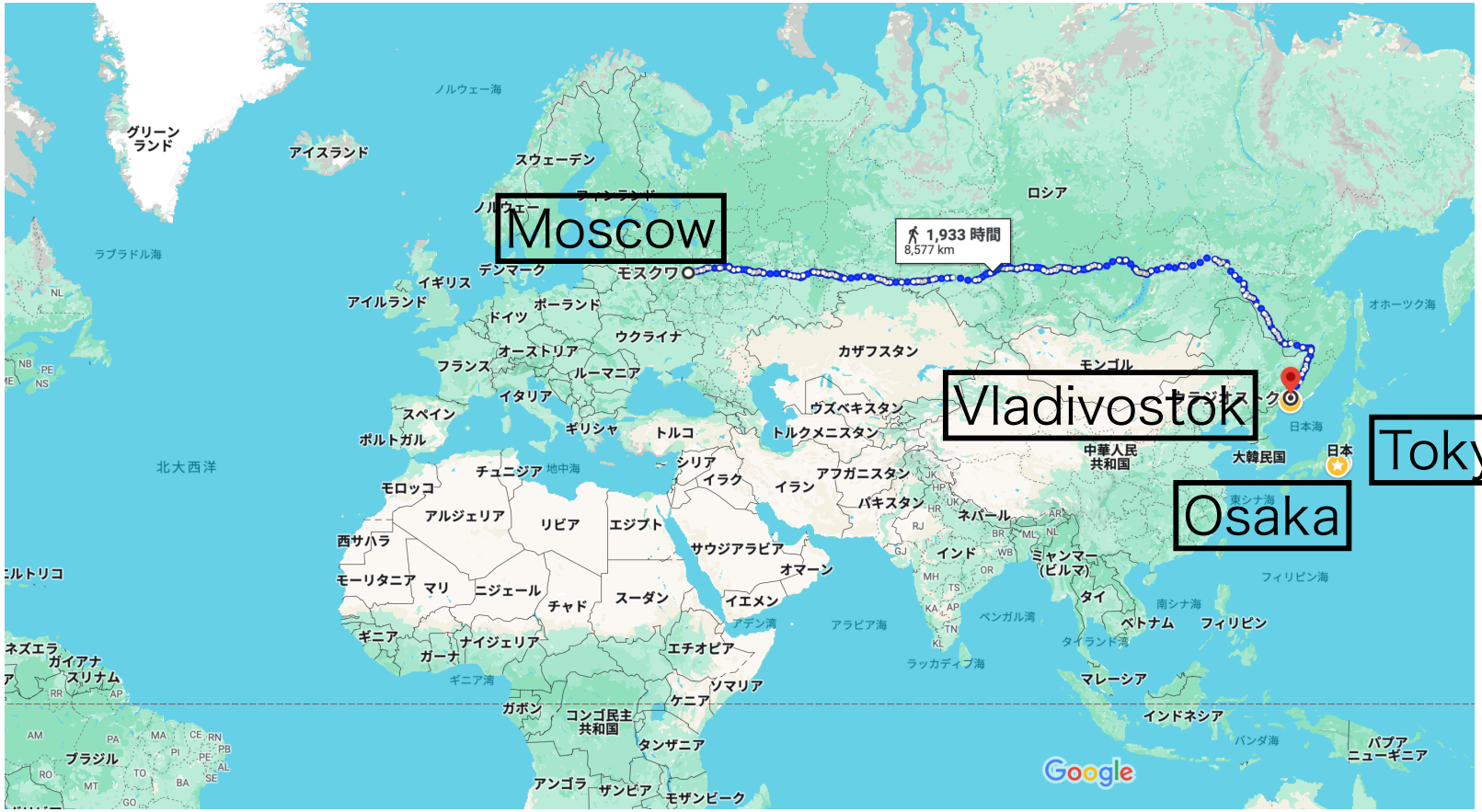
“From Quarks to Galaxies: Elucidating Dark Sides”

Dec, 1st, 2023

Our Team

Google

徒歩 8,577 km、1,933 時間



a/д Амур/P-297 経由　　1,933 時間

Brief

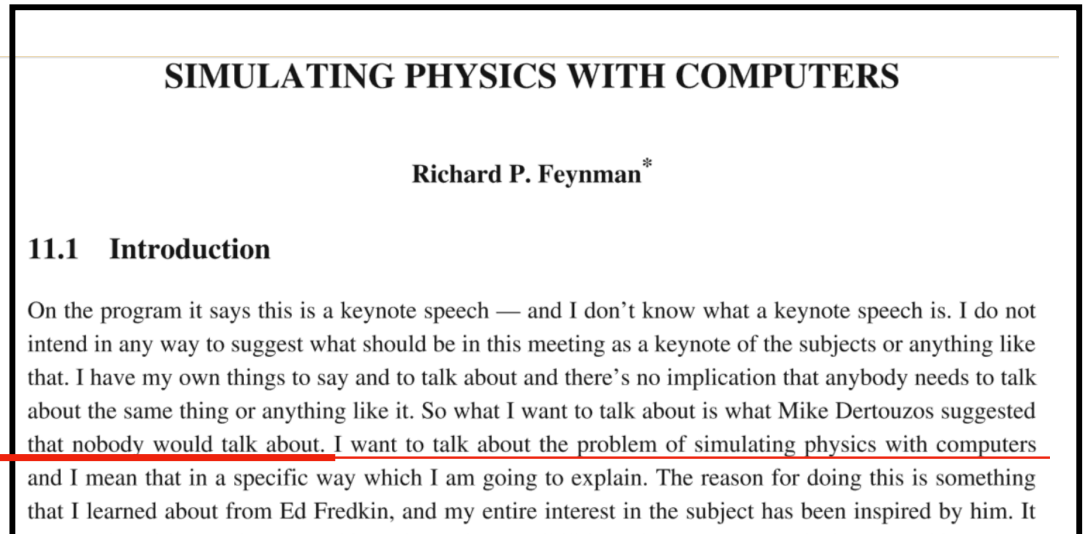
1. History of Quantum computers

- 1980, Y. Manin. ‘Computable and Uncomputable’. Sovetskoye Radio, Moscow, 128.

- 1980 Paul Benioff
  `Quantum mechanical model of the Turing Machine’
  Fortsch. Phys. 46 (1998) 423-442 (arXiv:quant-ph/9708054)

- 1981 R. P. Feynman, `Simulating physics with computers’. Inter. J. Theor. Phys., 21: 467.

I want to talk about the problem of simulation physics with computers



SIMULATING PHYSICS WITH COMPUTERS

Richard P. Feynman*

11.1 Introduction

On the program it says this is a keynote speech — and I don’t know what a keynote speech is. I do not intend in any way to suggest what should be in this meeting as a keynote of the subjects or anything like that. I have my own things to say and to talk about and there’s no implication that anybody needs to talk about the same thing or anything like it. So what I want to talk about is what Mike Dertouzos suggested that nobody would talk about. I want to talk about the problem of simulating physics with computers and I mean that in a specific way which I am going to explain. The reason for doing this is something that I learned about from Ed Fredkin, and my entire interest in the subject has been inspired by him. It

- 1960s, Landauer (IBM Watson Research Center)

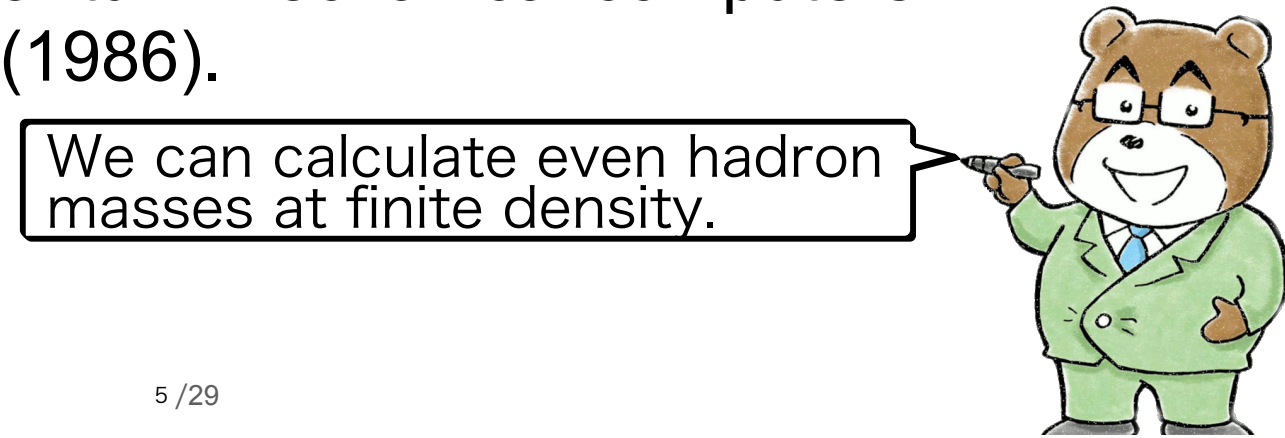
The limit of computers from Thermo-Dynamics ?
Computers generating no heat ?

Yes, for some data copy.
No, for the memory reset
because the entropy of a memory decreases,
and
we must compensate it by heat release.

- 1980 Paul Benioff
  `Quantum mechanical model of the Turing Machine'
  Fortsch. Phys. 46 (1998) 423-442 (arXiv:quant-ph/9708054)

- 1981 R. P. Feynman, `Simulating physics with computers'.
  Inter. J. Theor. Phys., 21: 467.

- 1985 R.P. Feynman, `Quantum mechanical computers'.
  Found Phys **16**, 507–531 (1986).



History of Quantum computers (continued)

- 1994 Peter Shor
  "Algorithms for quantum computation: discrete logarithms and factoring"

8=2x2x2, 15=3x5,⋯

Why is the factoring important ?

It plays an important role in RSA.
RSA (Rivest-Shamir-Adeleman) is a public key cryptosystem.
See Wikipedia

For us, the following Feynman's comment is important !

Simulating physics with computers !

Int. J. Theor. Phys. 21, 467–488 (1982)

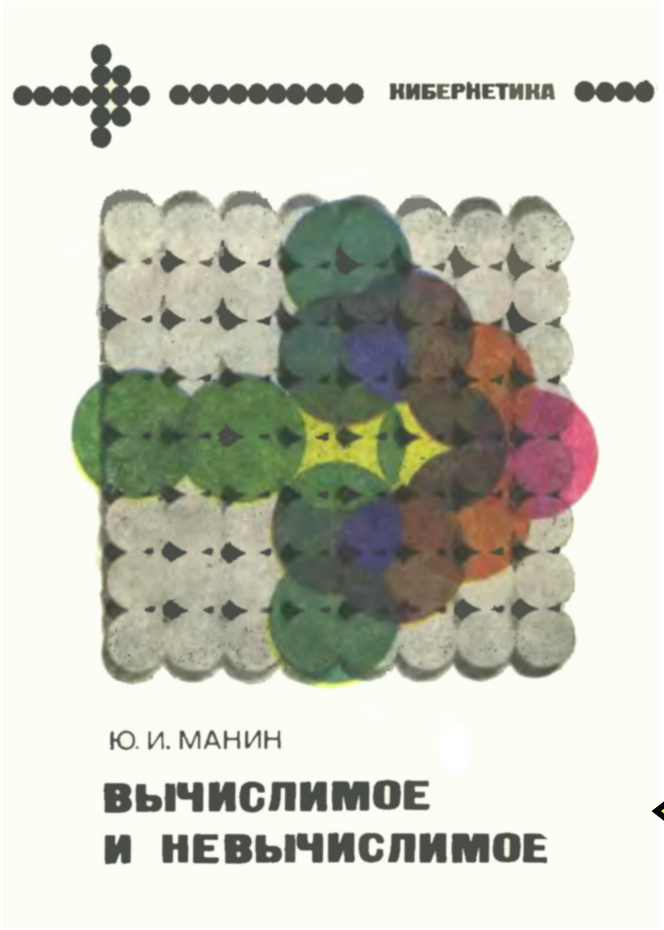
Quantum supremacy

Quantum Computer >> Clasical Computer

A programmable quantum computer can solve a problem that no classical computer can solve in any feasible amount of time, irrespective of the usefulness of the problem. (Wiki-pedia)

Yuri Manin (1980), Richard Feynman's (1981),
John Preskill (2012)

Yuri Ivanovich Manin
(Russian: Ю́рий Ива́нович Ма́нин)
1937 – 2023



He was one of the first to propose the idea of a quantum computer in 1980 with his book Computable and Uncomputable.

https://en.wikipedia.org/wiki/Yuri_Manin

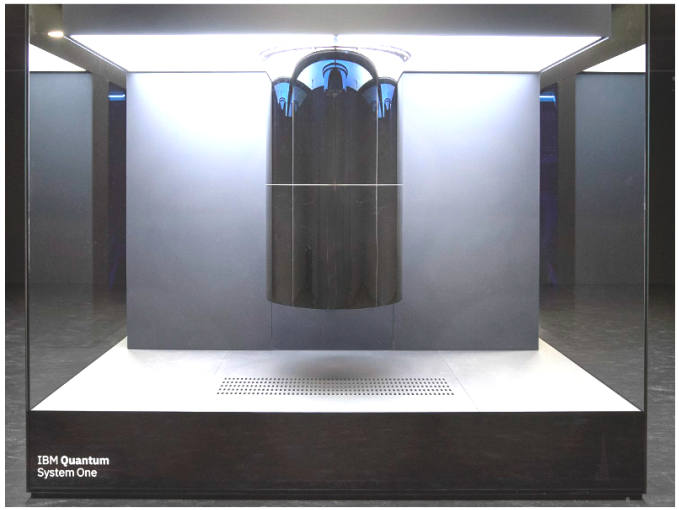
I thank Анатолий Корнеев for providing the book of Manin.

2. Quantum computer : Hardware

The product is 2-qubit quantum computer. Base on the theory of nuclear magnetic resonance.

https://www.spinquanta.com
/products-solutions/gemini

D-Wave sets up latest quantum computer in California
Reuters
May 12, 2022

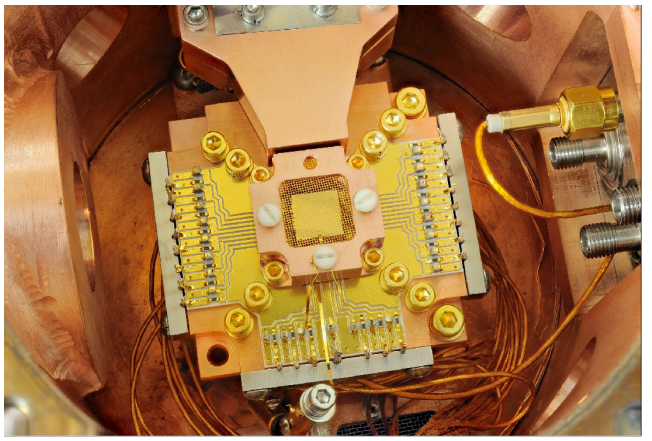


IBM Q System One, a quantum computer with 20 superconducting qubits.

(Wikipedia)

How to realize the Quantum bit

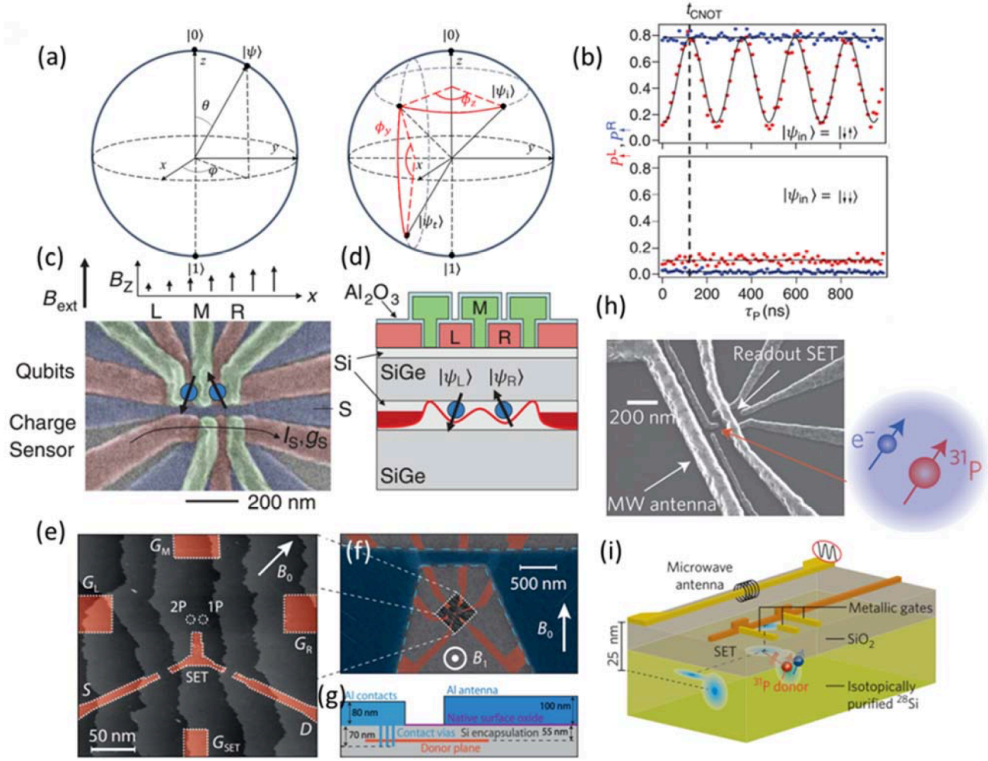
1. An IBM Quantum computer based on superconductiong qubits



2. Chip ion trap for quantum computing from 2011 at NIST (National Institute of Standard and Technology)

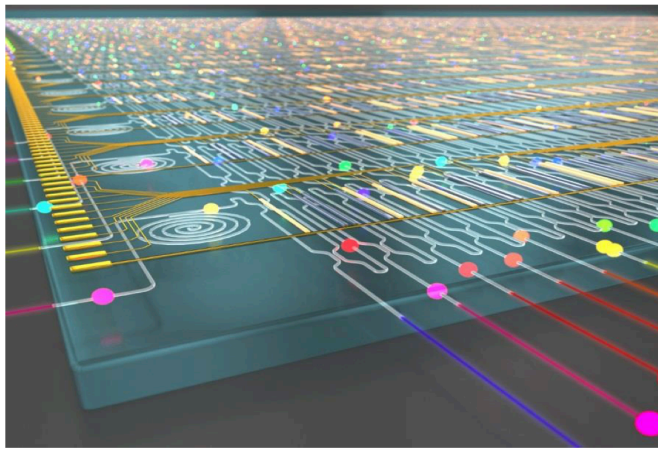
How to realize the Quantum bit (continued)

3. Semiconductor Quantum Computing



https://arxiv.org/pdf/1905.01592.pdf

4. photonic quantum computer



I don't know their detail.

https://arxiv.org/pdf/1805.10999.pdf

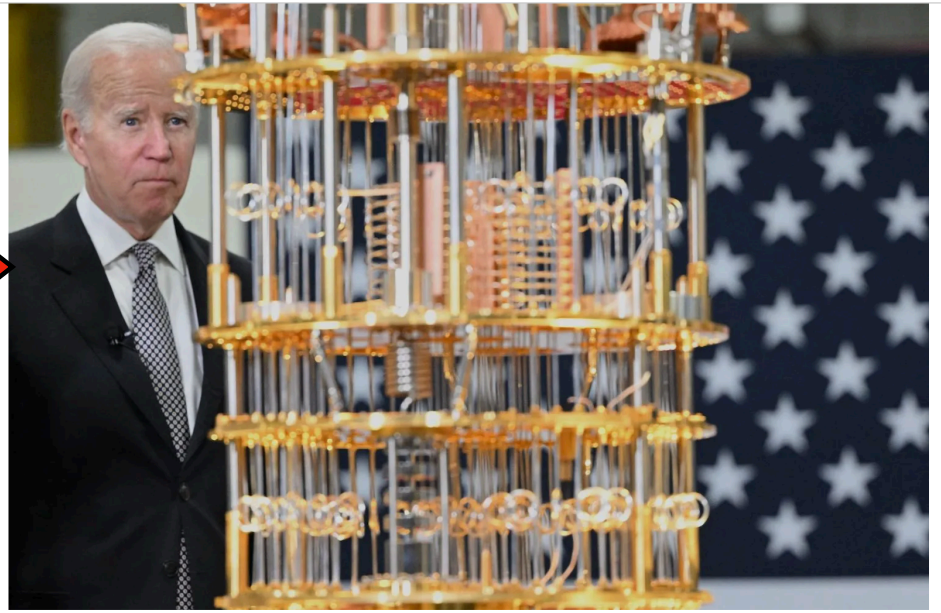
Schematic geometrical layout !

2. Present situation of the Quantum Computers

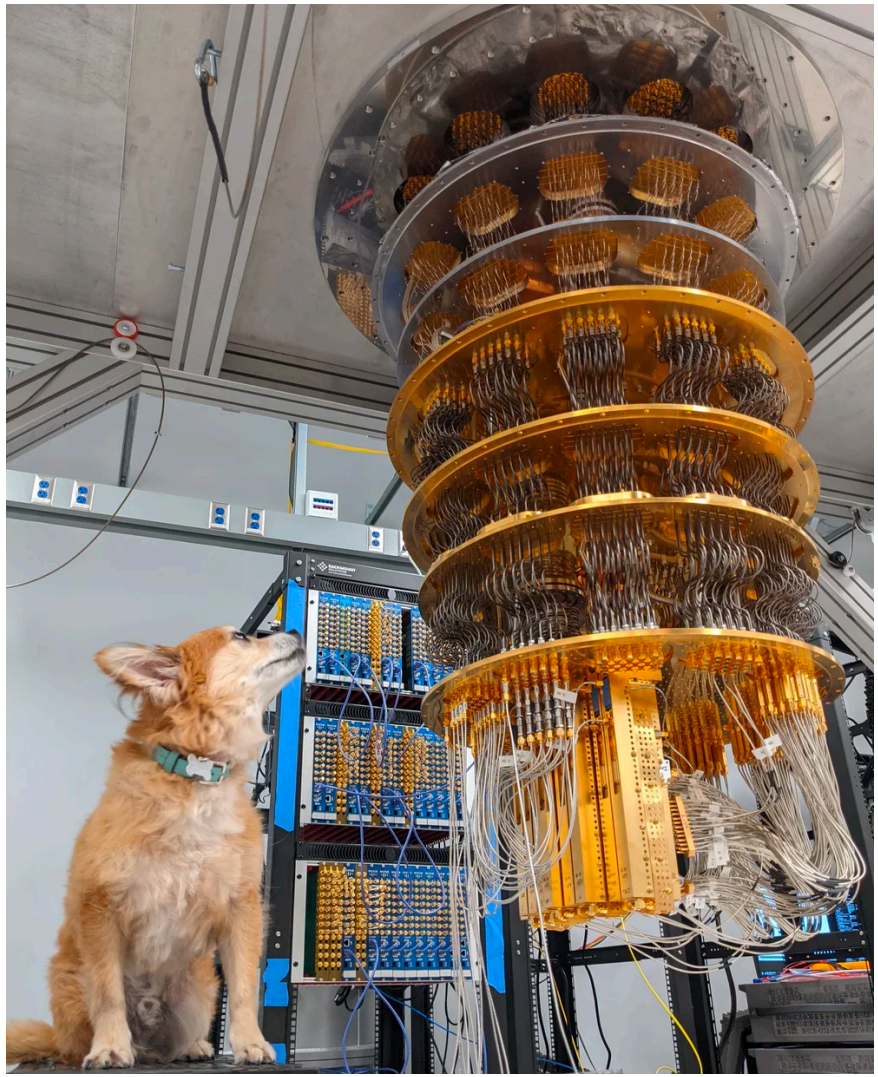
2.1 United state:

"White paper on Quantum Information Science and Technology for Nuclear Physics Input into U.S. Long-Range Planning, 2023"

U.S. President Joe Biden looks at a quantum computer as he tours the IBM facility in Poughkeepsie, New York
Oct. 6, 2022



Google quantum computers

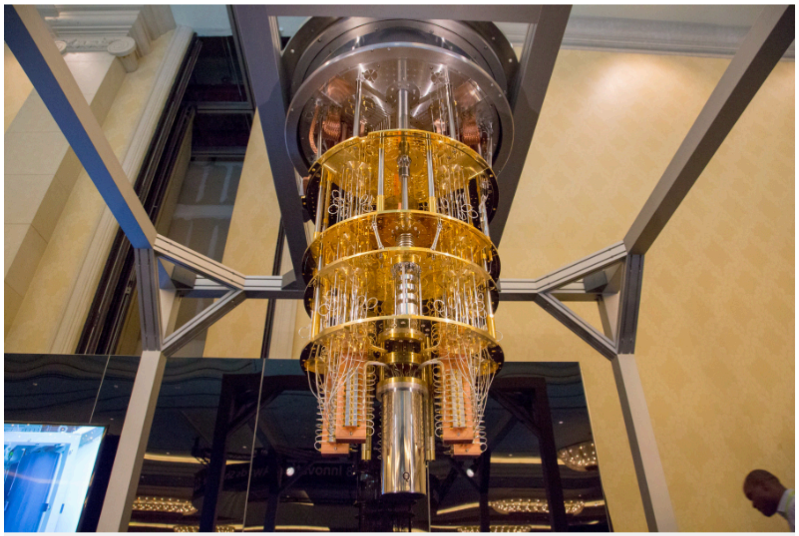


https://images.app.goo.gl/4UCtENPJve2YzJrL6

2.2 Russia builds lab for developing quantum artificial intelligence

Russian Quantum Center (RCC)

Mon, Jul 13, 2020, 9:23PM | Nuclear News



A quantum computer, such as this 50-bit version that IBM demonstrated at the International Consumer Electronics Show in 2018, is capable of solving tasks inaccessible to the most powerful "classic " supercomputer. (Photo: IBM)

Rosatom, Russia's state atomic energy corporation, and the Russian Quantum Center (RQC) on July 7 announced the creation of the first laboratory in Russia to research and develop machine learning and artificial intelligence (AI) methods on quantum computers, specializing in the application of these technologies in the nuclear industry. An agreement was signed between the RQC and Tsifrum, a Rosatom subsidiary that was created in 2019 to support the implementation of Rosatom's digitalization strategy.

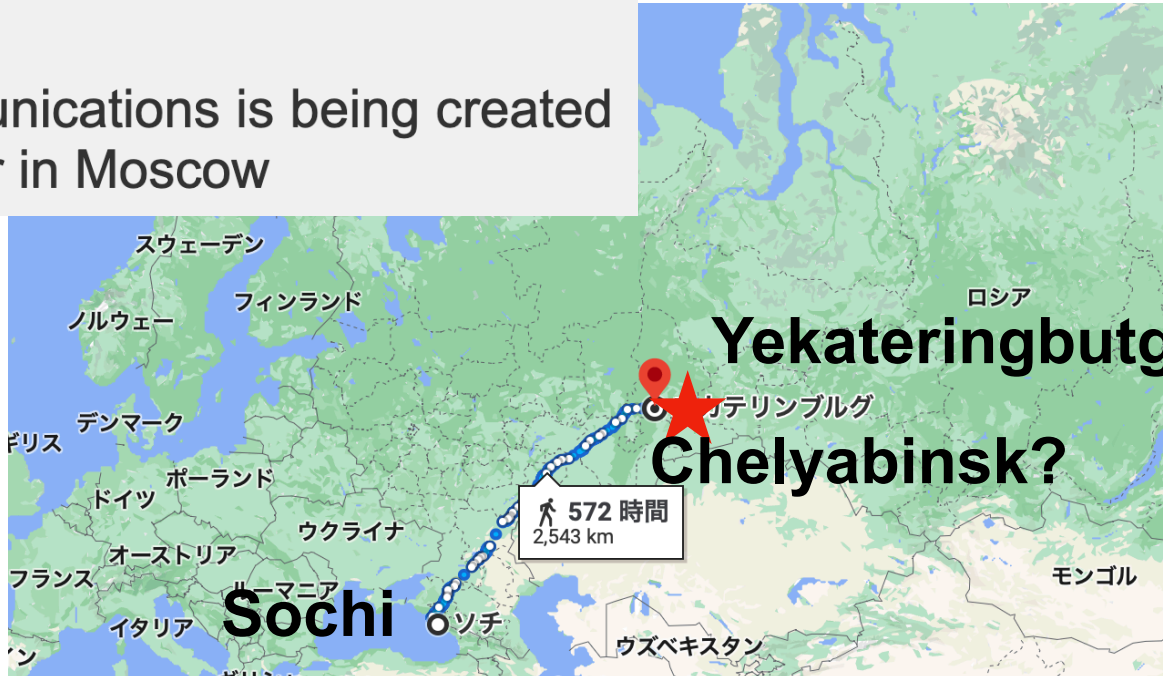
Quantum technologies in Russian Railways

2023

Russian Railways plans to extend the trunk quantum network to Sochi, Yekaterinburg and Chelyabinsk

Russian Railways will build a trunk quantum network to Kazan and Rostov for billions

A platform for testing quantum communications is being created on the basis of the Lomonosov cluster in Moscow



2.3 Europe

CERN Quantum Technology Initiative (QTI) is a comprehensive R&D and academic collaboration programme beyond the initial best-effort explorations, covering the different needs of the Organization and the high-energy physics (HEP) community. It is based on almost two years of pilot collaborations and investigations — primarily in quantum computing — related to possible applications that are core to activities in high-energy physics.

The Quantum Technology Initiative will define a roadmap and research programme in collaboration with the HEP and quantum-technology research communities. Setting up collaborations within the Member States and with international initiatives will allow CERN to stand at the forefront of the new quantum revolution and work to develop new computing, detectors, and communications systems, in addition to advancing knowledge of quantum systems and quantum information processing.

Today, quantum-technology activities are organised into four main domains of R&D and applications:

1. **Quantum computing and algorithms.**
2. **Quantum theory and simulation.**
3. **Quantum sensing, metrology and materials.**
4. **Quantum communication and networks.**

Italy

https://www.cineca.it/en/hot-topics/quantum-computers

For Italy, the EuroQCS-Italy project was selected. EuroQCS-Italy is an Italian-led consortium formed by **Italy (CINECA, hosting entity), Slovenia (ARNES) and Germany (FZJ).** The chosen quantum computer is a "neutral atoms" qubit technology computer, **capable of operate both in analog than in digital mode**. **The new machine will be installed at the Tecnopolo of Bologna, to be integrated with Leonardo (https://leonardo-supercomputer.cineca.eu/it/home-it/)** which, thanks to its particular and futuristic architecture, lends itself extraordinarily well to the purpose.

The Italian strategy for the development of quantum computing passes through a close link with the world of HPC. **The newborn National Center of HPC, Big Data and Quantum Computing,** financied by the Italian government and led by INFN (with the participation, especially at the infrastructural level, of CINECA) aims at the creation of a national network of supercomputers connected to