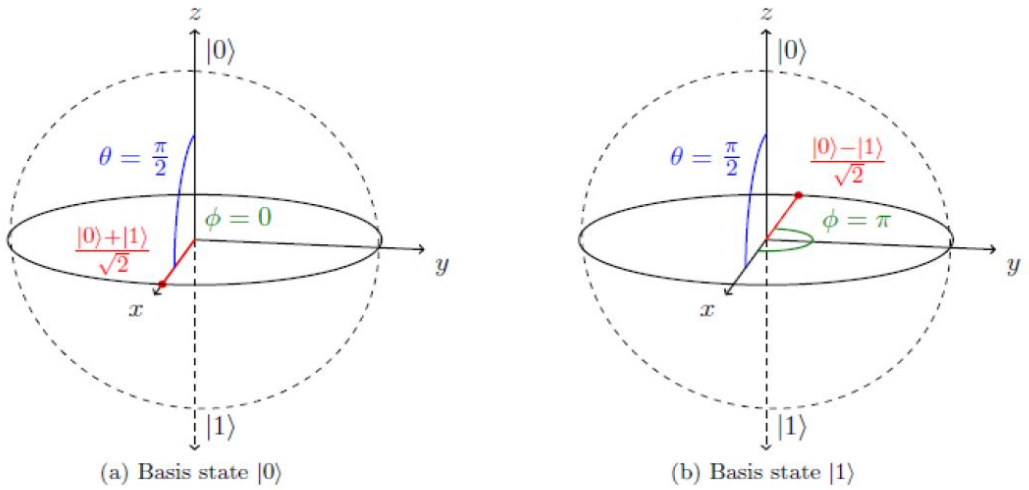
煤油灯科技

VICTORLAMP



(a) Basis state $|0\rangle$ (b) Basis state $|1\rangle$

全球量子计算技术现状分析（2021）

与当下工程师们计量子计算

多媒体课程：《与当下工程师们讲量子计算》

Shenzhen VictorLamp Technologies CO. Ltd.
http://www.victorlamp.com

Why

作为一名工程师，总是需要不断的学习新技术、新东西。

从C++，到JAVA，到Object c，GO，Rust；再Unix、Linux、Android、iOS；服务器通信，再到云计算，到区块链，……..

都是，顺风顺水，很快就能够学会并进入这个领域。

但是，到了量子计算，(⊙o⊙)…

给我的是薛定谔的猫，上帝掷骰子，平行世界，还有物理学家们的八卦，……..

再看看，《量子力学》，《原子物理》、《固体物理》、大篇的数学公司 ……..

我要的量子计算呢，量子计算呢，玄乎……..

有的人干脆就说，量子计算是骗子……..

VICTORLAMP

煤油灯科技

量子计算，未来高科技竞争的一个制高点

芯片、软件等竞争，“卡脖子”，过去已经过去。

未来高科技的竞争，未来技术是否还是“卡脖子”，量子计算技术是一个关键点。

市场研究预测，到 2030 年，量子计算将成为一个价值几千亿美元的产业。

量子编程，潜力十足的职业方向

与此同时，大量量子计算行业相关的工作岗位也将会随之诞生，如何做一名合格并优秀的量子计算工程师和程序员需要做一些知识上的准备了。

现代工程师与量子计算之间有一道槛，让人们觉得量子计算很遥远，很神秘。

市面上或者互联网上有大量的量子计算的资料，总体看来，要不就是科普类的，要不就是学术类的，很少有适合当下程序员或者工程师需要的资料或者课程。

如何让当下的IT从业人员或者程序员们，能够结合自己已有的知识积累快速的了解和理解量子计算技术，是本课程的出发点和目的。

商用量子计算机已经开始销售，一台量子计算机售价上亿

世界上已经有商业化的量子计算机，D-Wave公司，位于加拿大，是量子计算系统，软件和服务开发和商用的量子计算机公司。

D-Wave 2000Q量子计算机系统，价格大约每台1500万美元（约一亿人民币）。

2020年，英国政府向Rigetti Computing购买一台量子计算机，这是一项1000万英镑（折合9086万人民币）项目的一部分。

无论你是先知先觉，还是“后知后觉”，量子计算机“她”已经悄悄的来了！

煤油灯科技
VICTORLAMP

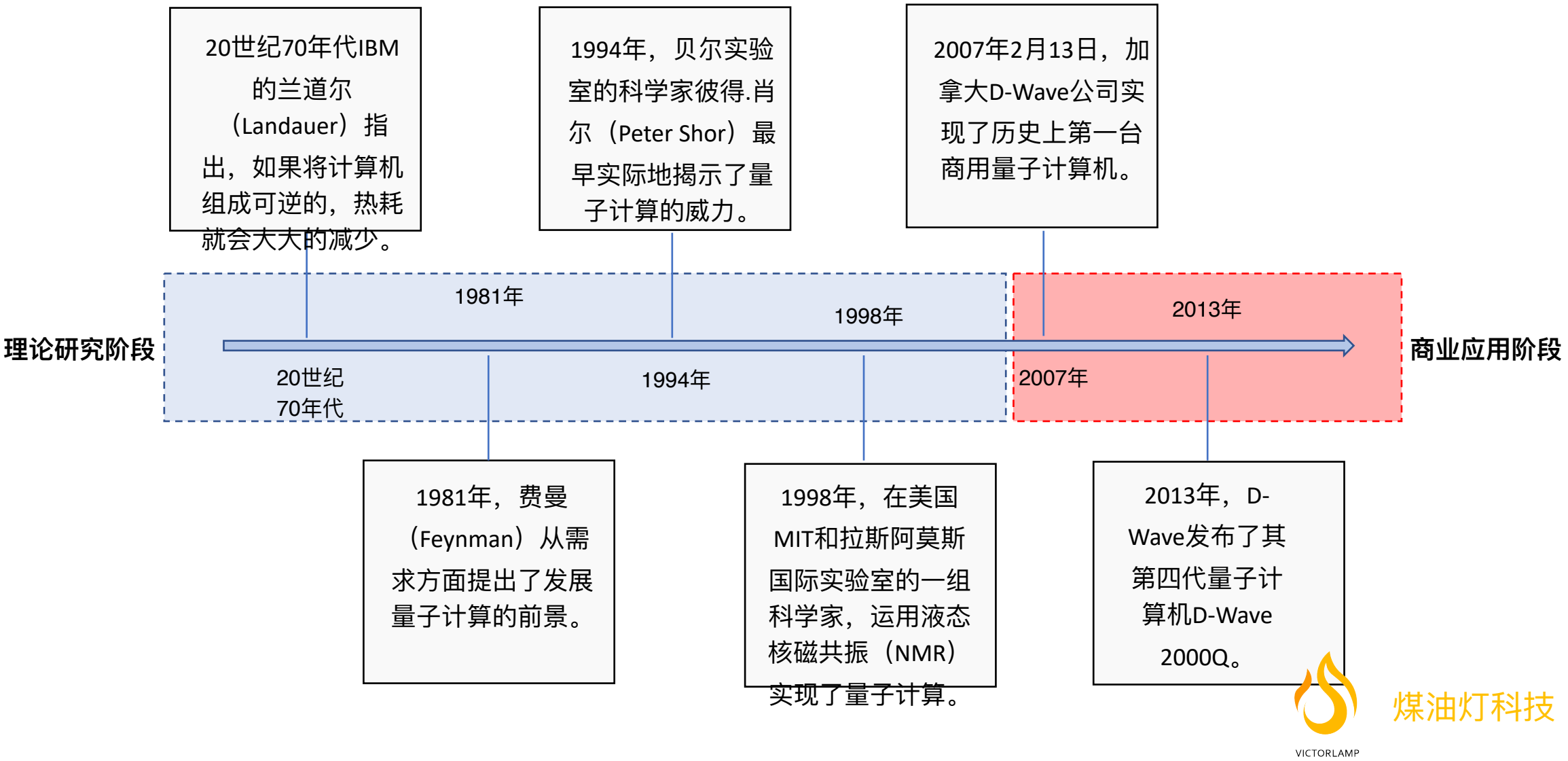
谁在买，谁在用量子计算机

目前D-Wave公司主要客户是：

- 洛克希德马丁公司
- 谷歌
- 美国宇航局（NASA）
- 大众汽车
- DENSO公司
- 南加州大学
- 美国洛斯阿拉莫斯国家实验室
- 美国橡树岭国家实验室

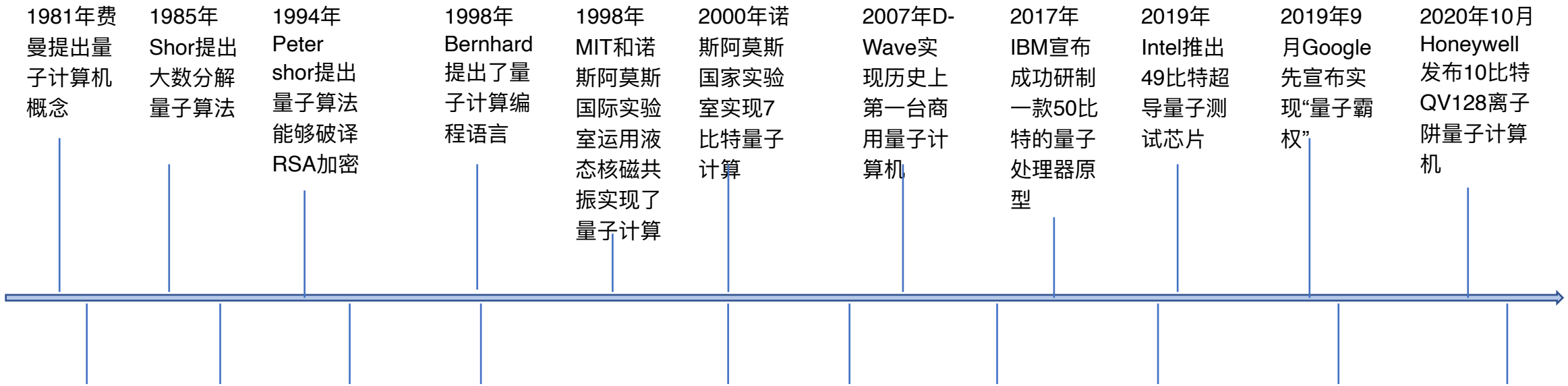
D-Wave表示，客户已经在广泛的商业和科学领域开发了150多个应用程序，其中包括航班时刻表，选举模型，量子化学，汽车设计，预防保健，物流和金融资产管理等。

量子计算机诞生的几个重要里程碑



煤油灯科技
VICTORLAMP

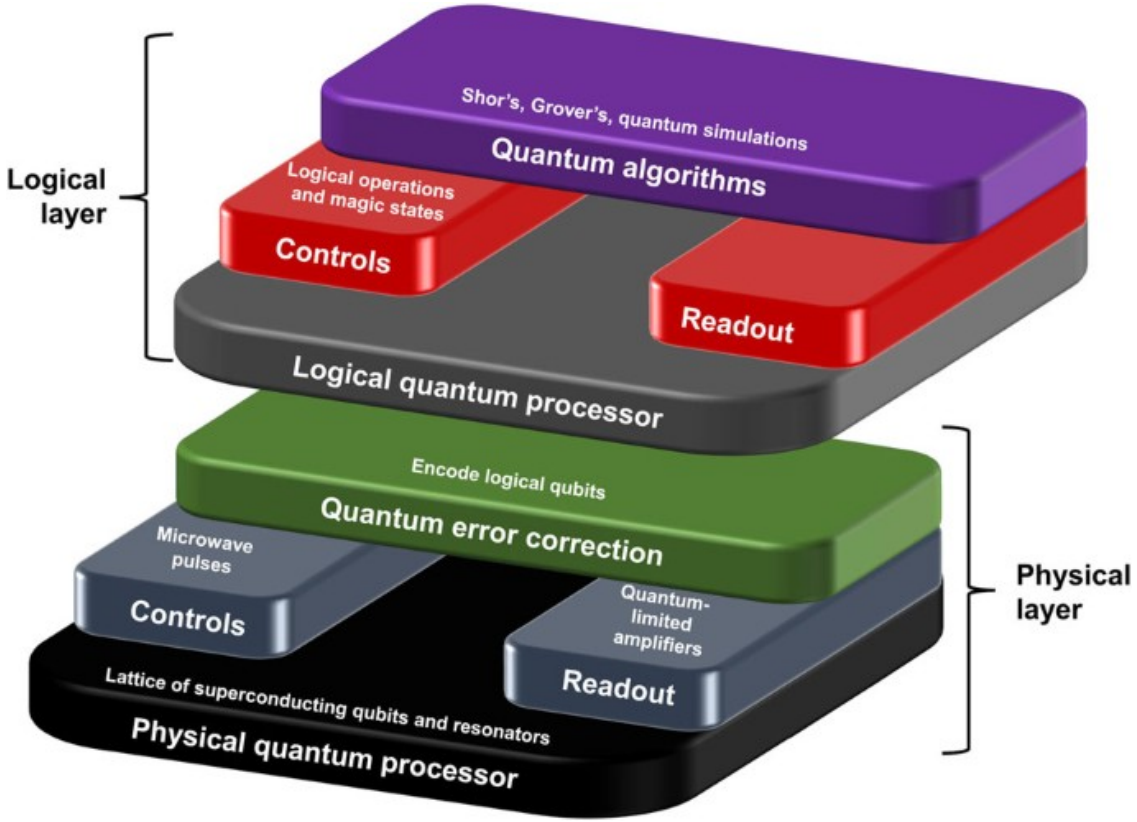
量子计算机进展的一些关键节点



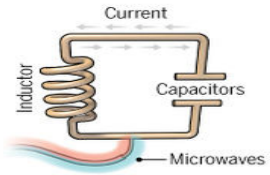
煤油灯科技

VICTORLAMP

量子计算技术栈和主要的技术方向



Superconducting loops



A resistance-free current oscillates back and forth around a circuit loop. An injected microwave signal excites the current into super-position states.

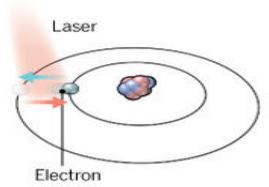
Longevity (seconds) 0.00005
Logic success rate 99.4%
Number entangled 9

Company support
Google, IBM, Quantum Circuits

Pros
Fast working. Build on existing semiconductor industry.

Cons
Collapse easily and must be kept cold.

Trapped ions



Electrically charged atoms, or ions, have quantum energies that depend on the location of electrons. Tuned lasers cool and trap the ions, and put them in super-position states.

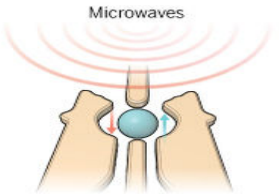
Longevity (seconds) >1000
Logic success rate 99.9%
Number entangled 14

Company support
ionQ

Pros
Very stable. Highest achieved gate fidelities.

Cons
Slow operation. Many lasers are needed.

Silicon quantum dots



These "artificial atoms" are made by adding an electron to a small piece of pure silicon. Microwaves control the electron's quantum state.

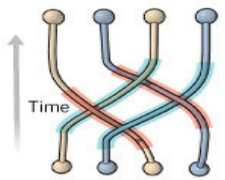
Longevity (seconds) 0.03
Logic success rate ~99%
Number entangled 2

Company support
Intel

Pros
Stable. Build on existing semiconductor industry.

Cons
Only a few entangled. Must be kept cold.

Topological qubits



Quasiparticles can be seen in the behavior of electrons channeled through semi-conductor structures.Their braided paths can encode quantum information.

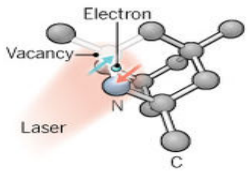
Longevity (seconds) N/A
Logic success rate N/A
Number entangled N/A

Company support
Microsoft, Bell Labs

Pros
Greatly reduce errors.

Cons
Existence not yet confirmed.

Diamond vacancies



A nitrogen atom and a vacancy add an electron to a diamond lattice. Its quantum spin state, along with those of nearby carbon nuclei, can be controlled with light.

Longevity (seconds) 10
Logic success rate 99.2%
Number entangled 6

Company support
Quantum Diamond Technologies

Pros
Can operate at room temperature.

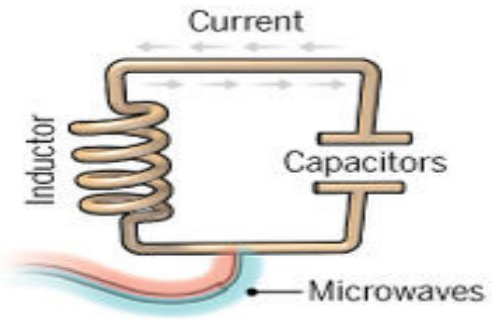
Cons
Difficult to entangle.

Note: Longevity is the record coherence time for a single qubit superposition state, logic success rate is the highest reported gate fidelity for logic operations on two qubits, and number entangled is the maximum number of qubits entangled and capable of performing two-qubit operations.

量子计算技术的主要方向：超导和离子阱

超导：无电阻电流沿回路来回震荡，注入的微波信号使电流兴奋，让它进入叠加态。

Superconducting loops



A resistance-free current oscillates back and forth around a circuit loop. An injected microwave signal excites the current into super-position states.

Longevity (seconds)	**0.00005**
Logic success rate	**99.4%**
Number entangled	**9**

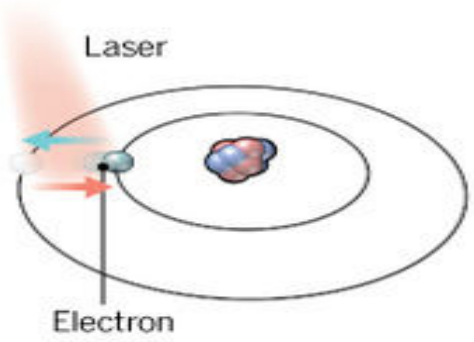
Company support
Google, IBM, Quantum Circuits

Pros
Fast working. Build on existing semiconductor industry.

Cons
Collapse easily and must be kept cold.

离子阱：离子的量子能取决于电子的位置；使用精心调整的激光可以冷却并困住这些离子，使它们进入叠加态。

Trapped ions



Electrically charged atoms, or ions, have quantum energies that depend on the location of electrons. Tuned lasers cool and trap the ions, and put them in super-position states.

Longevity (seconds)	**>1000**
Logic success rate	**99.9%**
Number entangled	**14**

Company support
ionQ

Pros
Very stable. Highest achieved gate fidelities.

Cons
Slow operation. Many lasers are needed.

量子计算技术的主要方向：量子点和拓扑

半导量子点：通过向纯硅加入电子，科学家们造出了这种人造原子；微波控制着电子的量子态

Silicon quantum dots

These "artificial atoms" are made by adding an electron to a small piece of pure silicon. Microwaves control the electron's quantum state.

Longevity (seconds)	**0.03**
Logic success rate	**~99%**
Number entangled	**2**

Company support

Intel

Pros

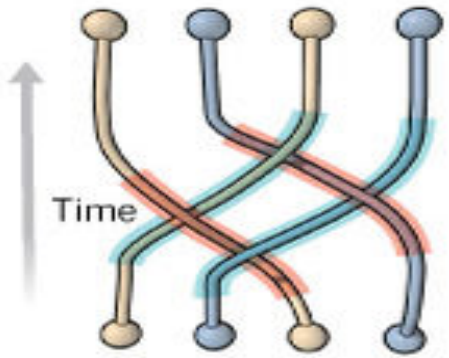
Stable. Build on existing semiconductor industry.

Cons

Only a few entangled. Must be kept cold.

量子拓扑：电子通过半导体结构时会出现准粒子，它们的交叉路径可以用来编写量子信息。

Topological qubits



Quasiparticles can be seen in the behavior of electrons channeled through semi-conductor structures.Their braided paths can encode quantum information.

Longevity (seconds)	**N/A**
Logic success rate	**N/A**
Number entangled	**N/A**

Company support

Microsoft, Bell Labs

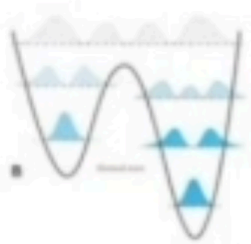
Pros

Greatly reduce errors.

Cons

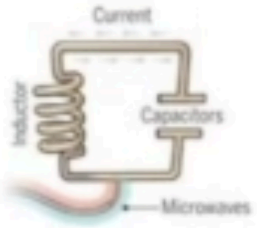
Existence not yet confirmed.

当前投入到量子计算领域的主要公司和机构（按照技术方向分）



recuit quantique

D-Wave



boucles supra-conductrices

IBM

intel Google

rigetti

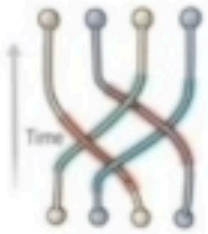
UCSB

qci

cea

OXFORD QUANTUM

Raytheon



qubits topologiques

Microsoft

NOKIA

TU Delft

QuTech

optique linéaire

XANADU

hp

UNIVERSITY OF OXFORD

TUNDRA SYSTEMS GLOBAL

quantum dots silicium

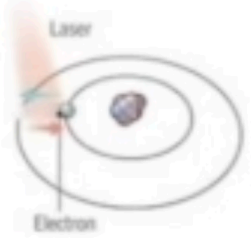
intel

cea

Yale University

NTT

NOKIA



ions piégés

IONQ

MIT

UNIVERSITY OF MARYLAND

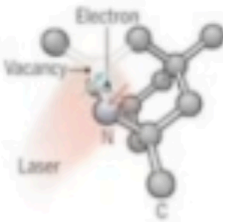
Sandia National Laboratories

HARVARD UNIVERSITY

JGU

IQI

IQST

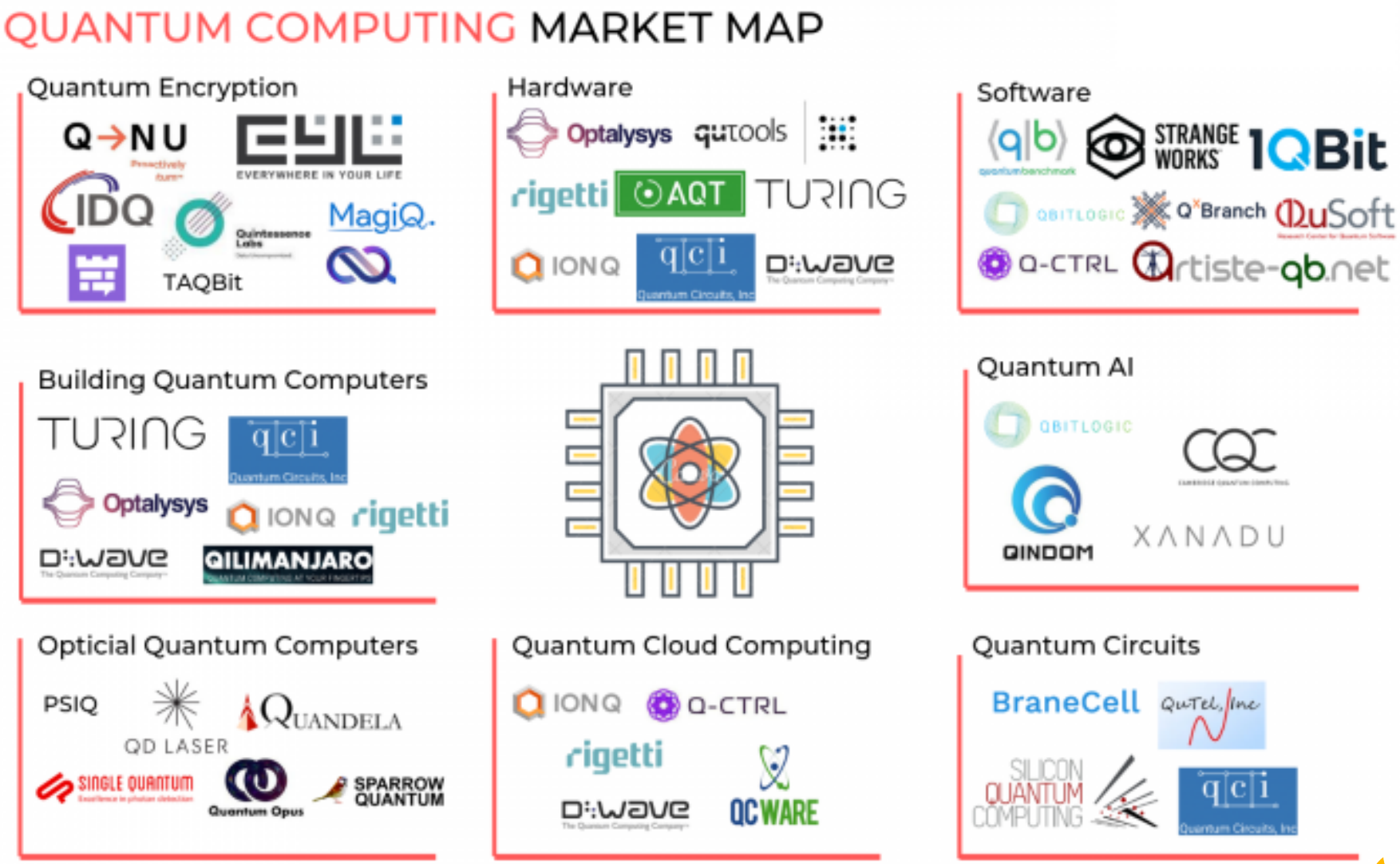


cavités diamants

QDTI

cea

当前投入到量子计算领域的主要公司和机构（按照投入领域分）



煤油灯科技

VICTORLAMP

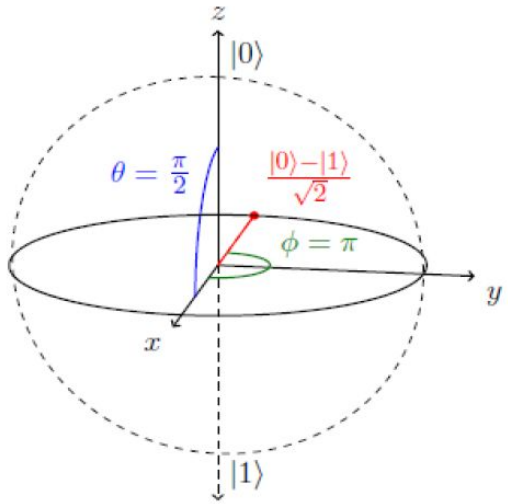
I’m not happy with all the analyses that go with just the classical theory, because Nature isn’t classical, dammit, and if you want to make a simulation of nature, you’d better make it quantum mechanical, and by golly it’s a wonderful problem, because it doesn’t look so easy. It’s not a Turing machine, but a machine of a different kind.

—Richard Feynman, 1981

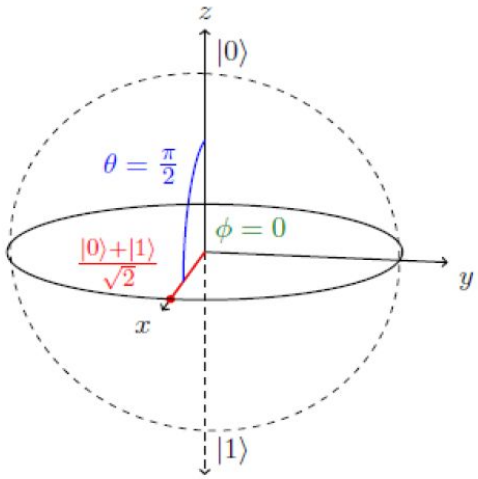
我们生活的自然世界是量子化的，如果要用机器模拟真实的自然世界最好的办法就是量子计算，量子计算机不再是图灵计算模型，而是一种全新的计算模型，颠覆当前计算机世界的全新模型。

VICTORLAMP

Shenzhen VictorLamp Technologies CO. Ltd.
http://www.victorlamp.com



(b) Basis state $|1\rangle$



(a) Basis state $|0\rangle$

与当下工程师们计量子计算

多媒体课程：《与当下工程师们讲量子计算》