

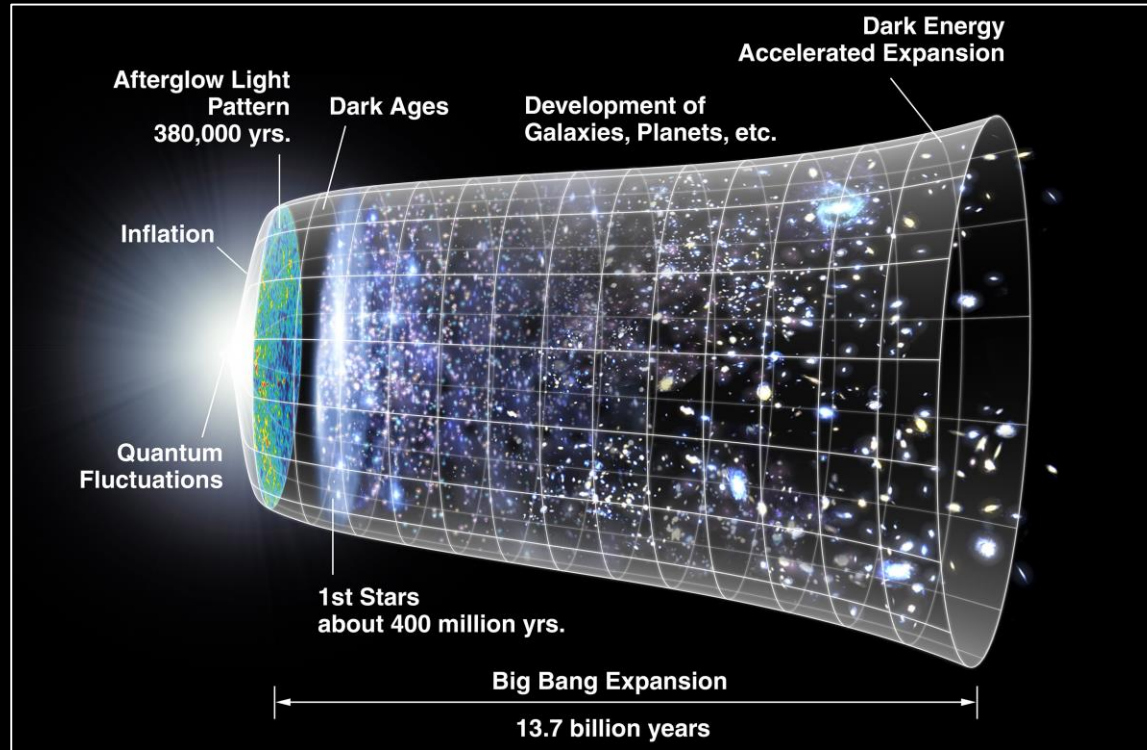
THE ART OF QUANTUM

We all live in ...

We all live in a yellow submarine



We all live in quantum Universe



**Classicality is an emergent
phenomenon – everything is rooted in
the realm of quantum**

**(Classical) Reality is merely an illusion
albeit a very persistent one.**

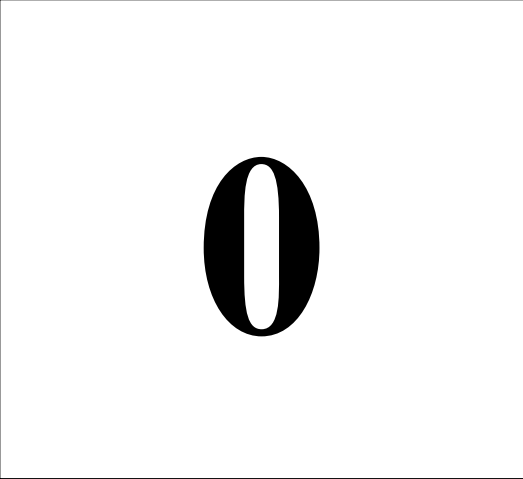
A.Einstein

THREE PILLARS OF QUANTUM

- **Quantum superposition principle**
- **Quantum measurements**
- **Quantum correlations – quantum entanglement**

QUANTUM SUPERPOSITION

BIT vs QUBIT



0

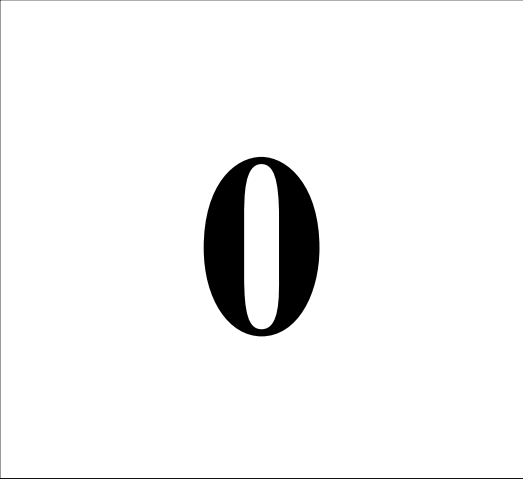
either / or



1

QUANTUM SUPERPOSITION

BIT vs QUBIT



0

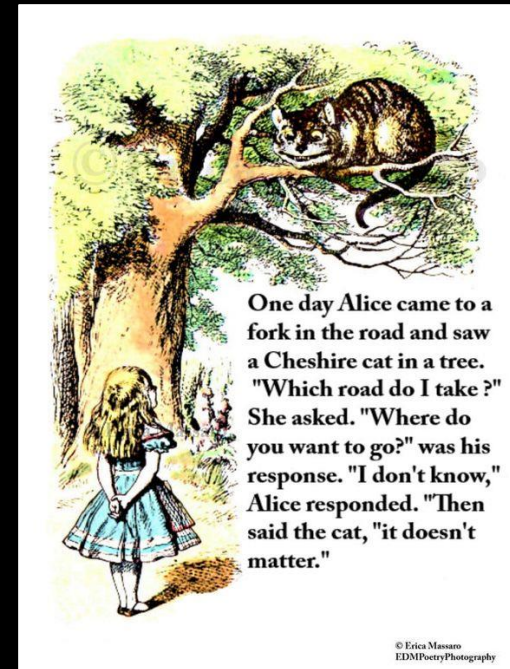
simultaneously



1

QUANTUM MEASUREMENTS

- Outcome of a measurement performed on a quantum system can only be predicted statistically – with some probability.
- Quantum world at a level of classical description is random.
- By performing a measurement on a single qubit we obtain a result either “0” or “1”, but we can’t predict it with certainty.
- Information gain vs disturbance. Measured quantum system collapses into the state that is registered on the measurement device.
- *Properties that were determined by quantum measurements did not exist before the measurements were performed.*



QUANTUM ENTANGLEMENT

$$\begin{array}{|c|} \hline 00 \\ \hline \end{array} + \begin{array}{|c|} \hline 11 \\ \hline \end{array}$$

$$\begin{array}{|c|} \hline ?? \\ \hline \end{array}$$

QUANTUM ENTANGLEMENT

“spooky action at distance”

EINSTEIN ATTACKS QUANTUM THEORY

Scientist and Two Colleagues
Find It Is Not 'Complete'
Even Though 'Correct.'

SEE FULLER ONE POSSIBLE

Believe a Whole Description of
'the Physical Reality' Can Be
Provided Eventually.

"If you think you understand quantum mechanics, you don't understand quantum mechanics."

Richard Feynman

IMAGINE

MOST STRUCTURED AND COMPLEX MATTER IN THE UNIVERSE

MOST STRUCTURED AND COMPLEX MATTER IN THE UNIVERSE



- **The average human brain has about 100 billion neurons.**
- **Each neuron may be connected to up to 10,000 other neurons, passing signals to each other via as many as 1,000 trillion synaptic connections, equivalent by some estimates to a computer with a 1 trillion bit per second processor.**
- **The human brain's memory capacity up to 1,000 terabytes**
- **How the physical structure of brain relates to its functionality?**

EAVESDROPPING BRAIN

Jack Gallant lab at UC Berkley

Cognitive, computational and systems neuroscience

One human subject underwent fMRI brain scanning while viewing a complex natural movie. Voxel-wise modeling was used to estimate a forward encoding model for each location in visual cortex (see Nishimoto et al., 2011). For each one second segment of the movie, the encoding model was used in decoding mode to identify, from a library of 5000 hours of random video, 100 random clips most likely to be similar to the original clip that elicited the measured brain activity.

CAN HUMAN MIND BE DOWNLOADED ON A COMPUTER?

What would be needed:

- **Better sensors**
- **Better memory**
- **Better processors**
- **Better security**

QUANTUM COMPUTERS ?

“...trying to find a computer simulation of physics, seems to me to be an excellent program to follow out...and 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.”



Richard Feynman

QUANTUM INFORMATION TECHNOLOGIES



“[QIT] is a radical departure in information technology, more fundamentally different from current technology than the digital computer is from the abacus”.

William D. Phillips, 1997 Physics Nobel Laureate

CAN HUMAN MIND BE DOWNLOADED AND OPERATED ON A COMPUTER?

I THINK YES!

What is needed:

- **Quantum sensors**
- **Quantum memory**
- **Quantum processors**
- **Quantum security**



We are all agreed that your theory is crazy. The question that divides us is whether it is crazy enough to have a chance of being correct.

Niels Bohr

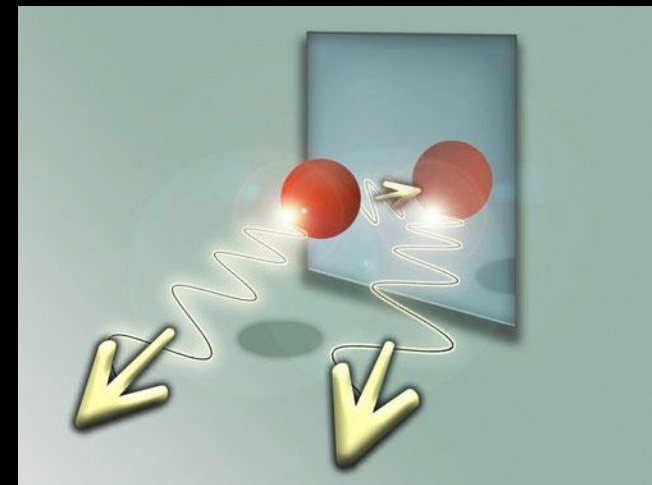
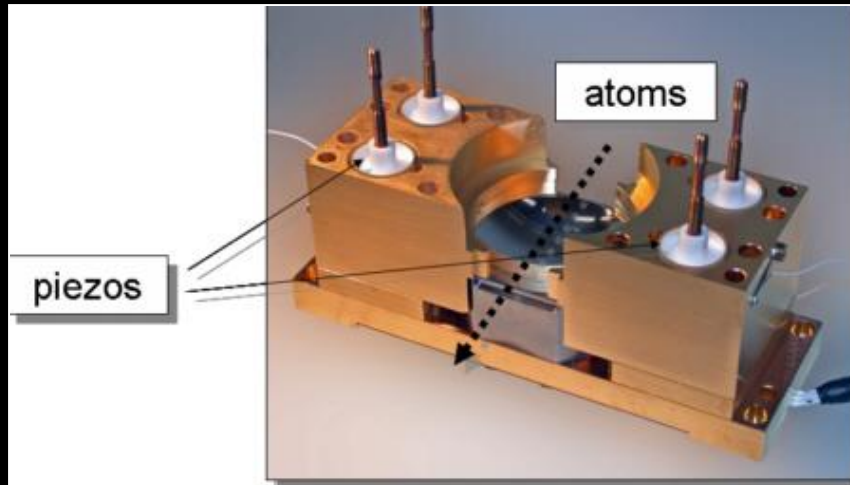
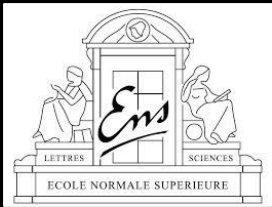
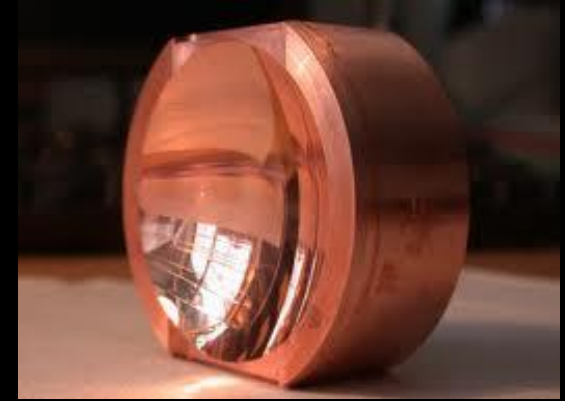
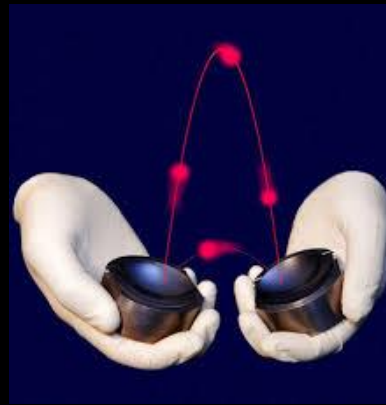
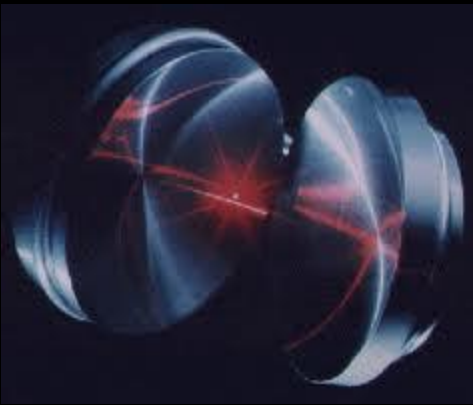
MANIPULATIONS WITH INDIVIDUAL Q-SYSTEMS



In the first place it is fair to state that we are not experimenting with single particles, any more than we can raise Ichthyosauria in the zoo. We are scrutinizing records of events long after they have happened.”

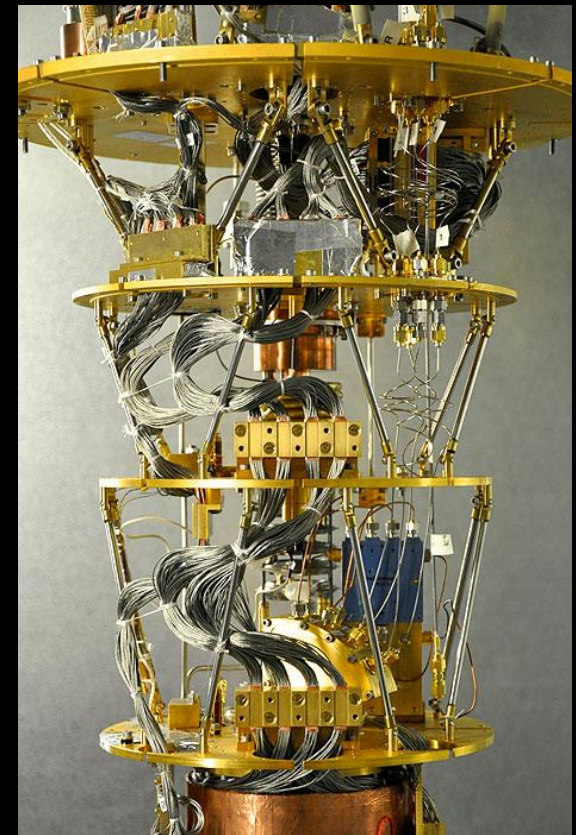
E. Schrödinger, 1952

PHOTONS IN OPTICAL RESONATORS



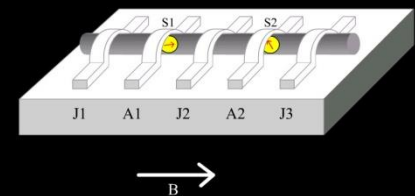
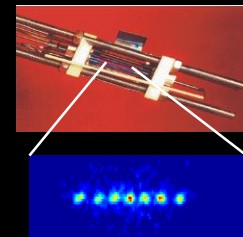
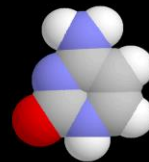
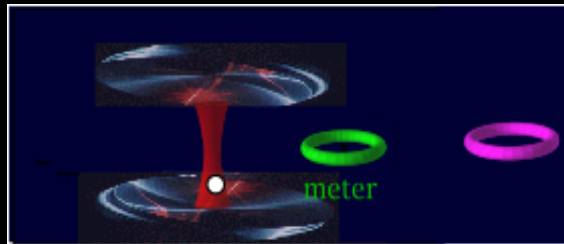
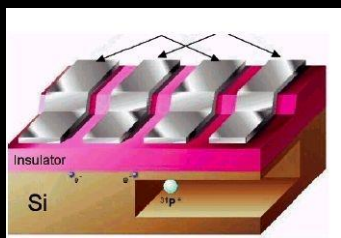
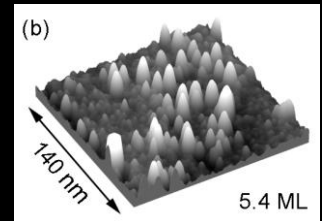
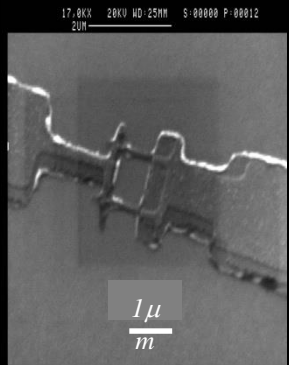
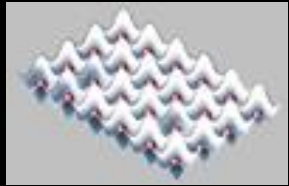
QUANTUM ARTIFICIAL GENERAL INTELLIGENCE

In support of NASA's Quantum Artificial Intelligence Laboratory (QuAIL), the NAS facility hosts a 1,097-qubit D-Wave 2X™ quantum computer. The QuAIL project is a collaborative effort among NASA, Google, and Universities Space Research Association (USRA) to explore the potential for quantum computers to tackle optimization problems that are difficult or impossible for traditional supercomputers to handle.

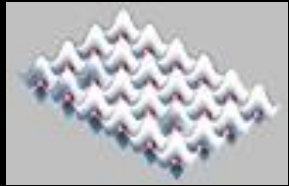


Support structure for installation of the D-Wave Vesuvius processor, which is cooled to 20 millikelvin (near absolute zero).

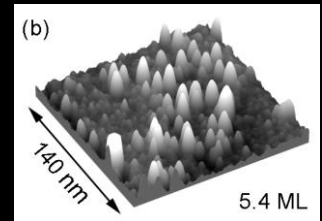
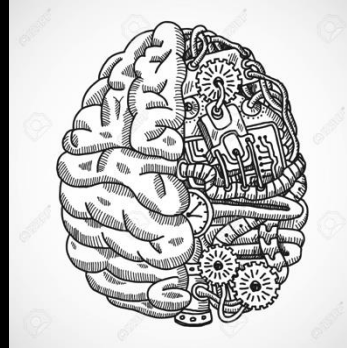
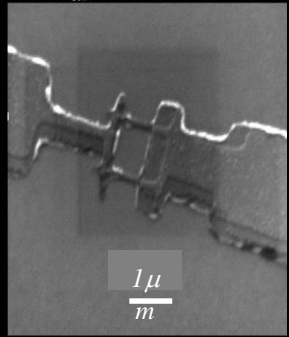
QUANTUM PROCESSORS



QUANTUM PROCESSORS

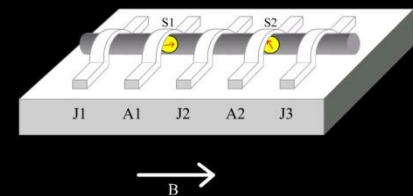
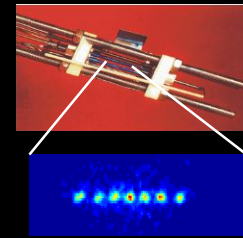
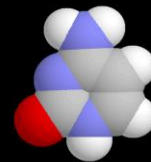
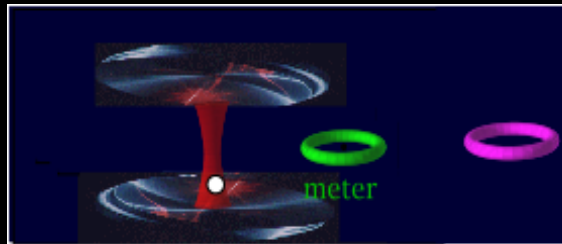
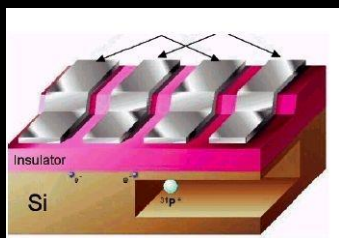


17.0kx 20kV WD:25nm S:00000 P:00012
ZUN



(b)

140 nm
5.4 ML



Sun'c said: The art of quantum is the most important art for the state.

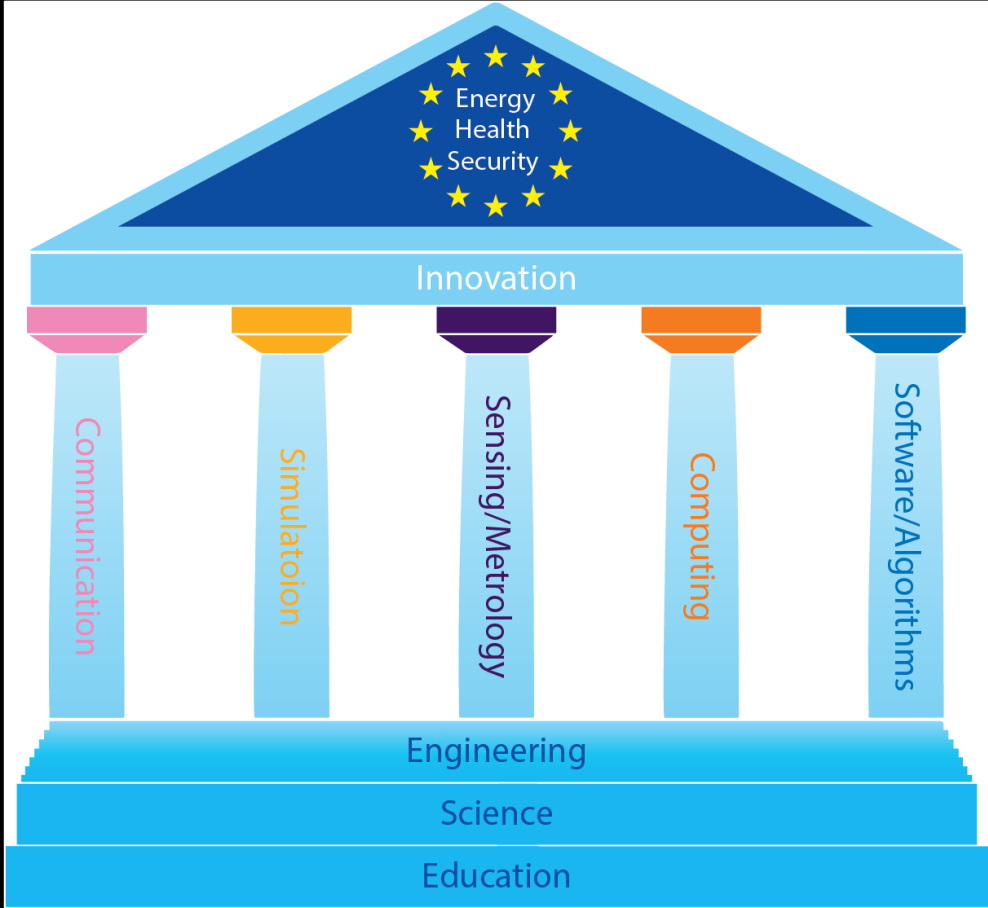
Sun'c
The Art of War
Chapter I, Planning

QUANTUM EUROPE 2016

(Amsterdam 17th May, 2016)

*EU Commissioner for Digital Economy and Society, Günther Oettinger, announced the **investment of one billion Euro** in a new **Flagship** on quantum technologies. “Building on the strong support for the Quantum Manifesto, we aim to launch an ambitious, large-scale Flagship initiative to unlock the full potential of quantum technologies, accelerate its development and bring commercial products to the consumer marketplace.”*





***“Begin at the beginning,” the King said gravely,
“and go on until you come to the end, then
stop.”***

Lewis Carroll
Alice in Wonderland