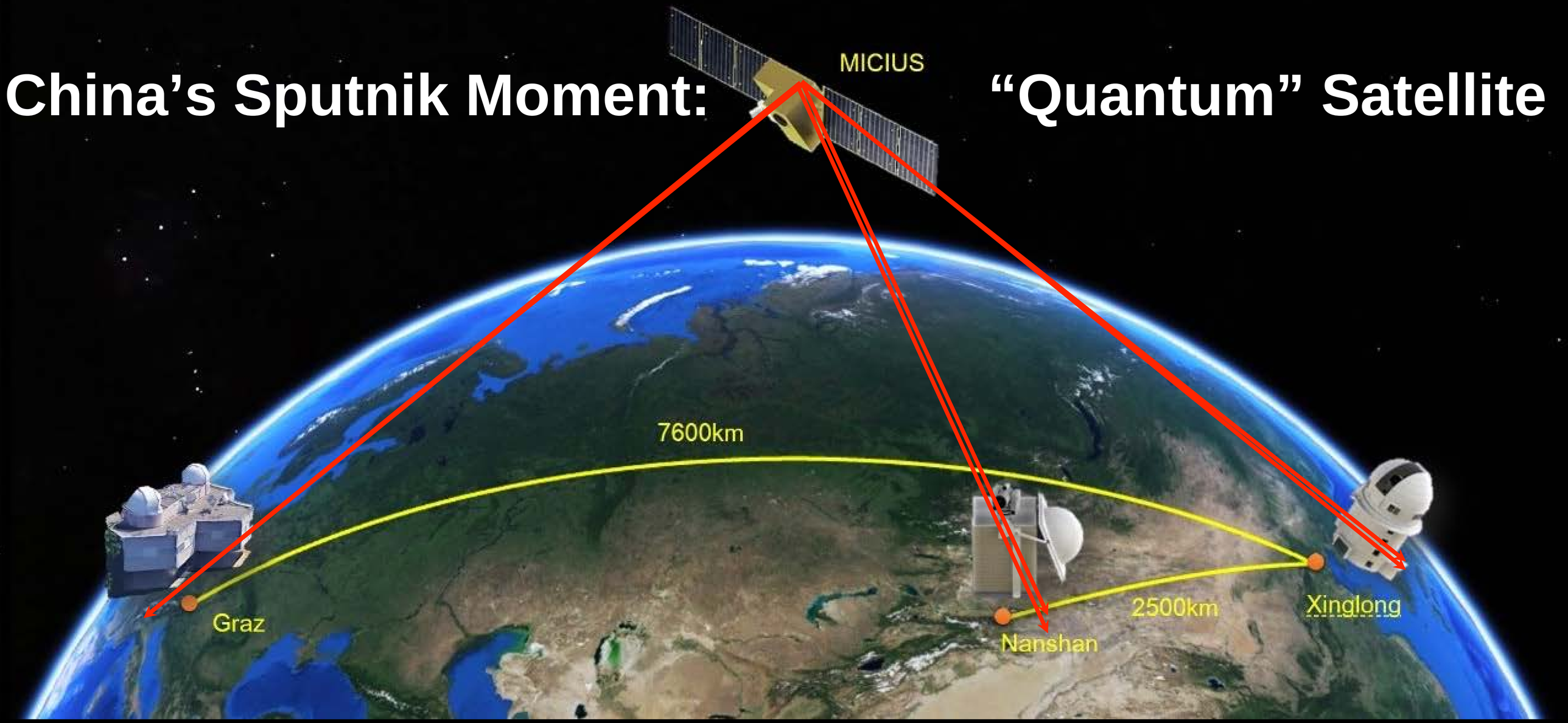
Quantum Photonics: a quantum leap for UVA

Olivier Pfister, Ph.D.
Professor of Physics
College and Graduate School of Arts & Sciences

UNIVERSITY of VIRGINIA

China’s Sputnik Moment: “Quantum” Satellite



The National Quantum Initiative

Union Calendar No.

115TH CONGRESS
2D SESSION

H. R. 6227

[Report No. 115–]

To provide for a coordinated Federal program to accelerate quantum research and development for the economic and national security of the United States.

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The U.S. National Quantum Initiative in numbers

$1.3B total for Academia, Government Labs and Industry

National Science Foundation:
$250M for 5-year Multidisciplinary Centers for Quantum Research and Education

Department of Energy:
$100M program in 2019. Quantum Centers in 2020

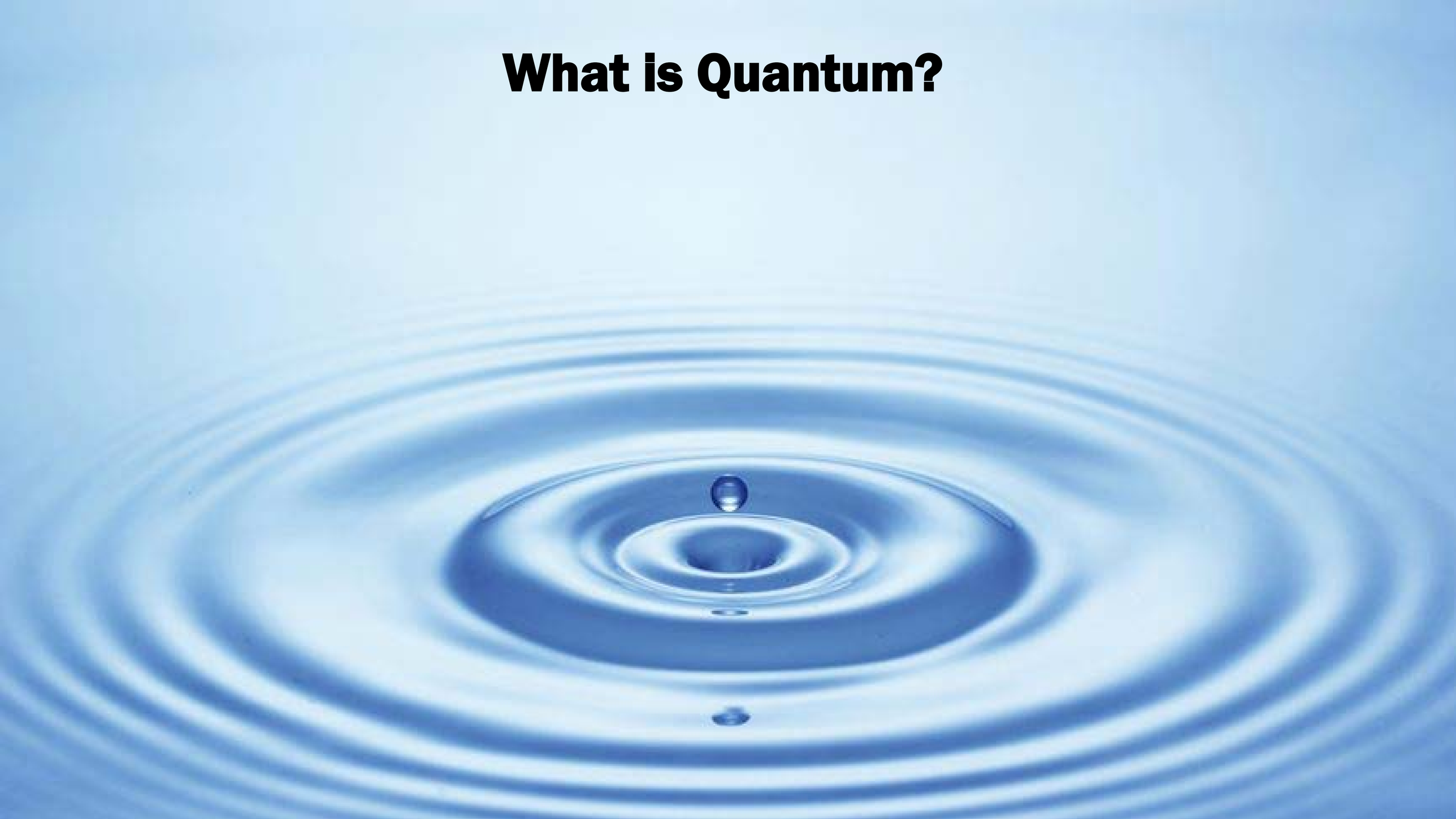
The U.S. National Quantum Initiative

Approved unanimously by US House of Representatives on Sept 13, 2018

Supported by White House

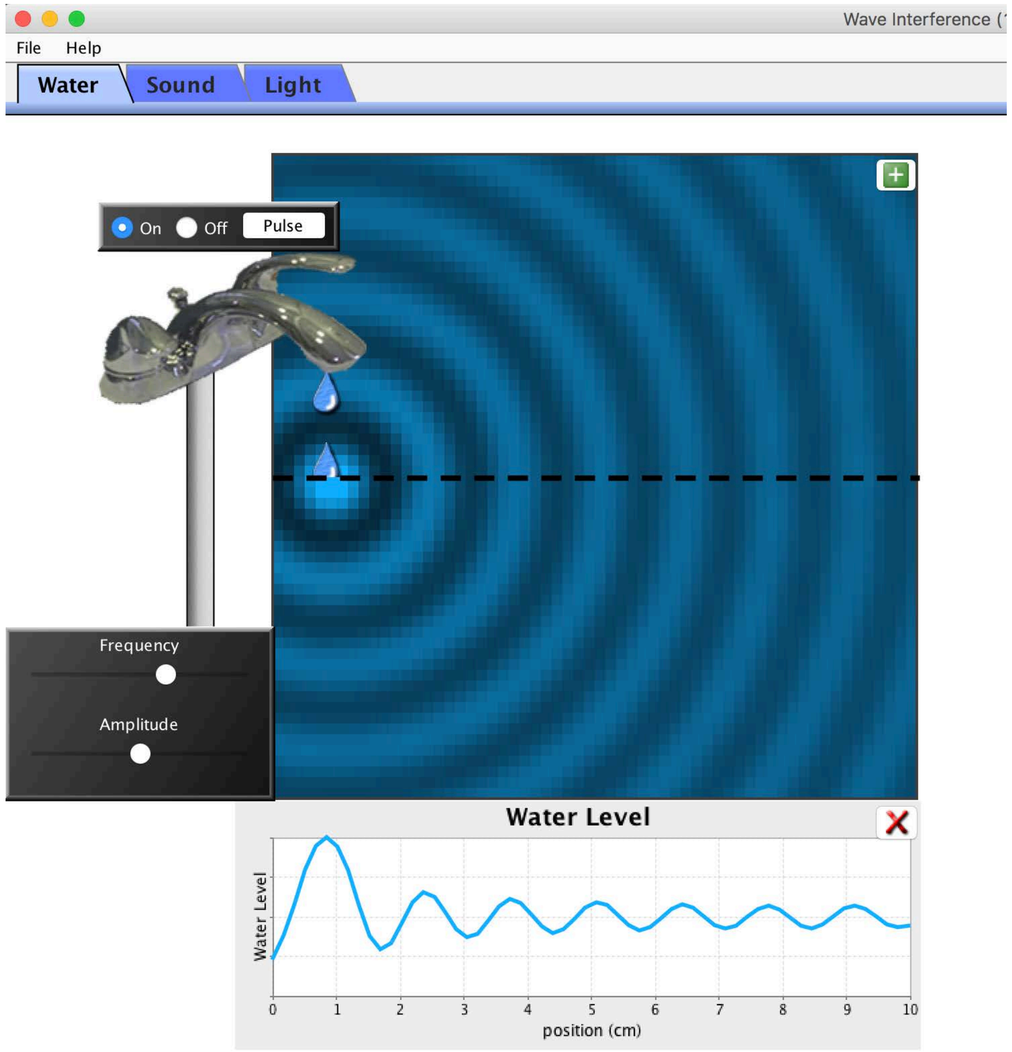
Now waiting for U.S. Senate for final vote

What is Quantum?

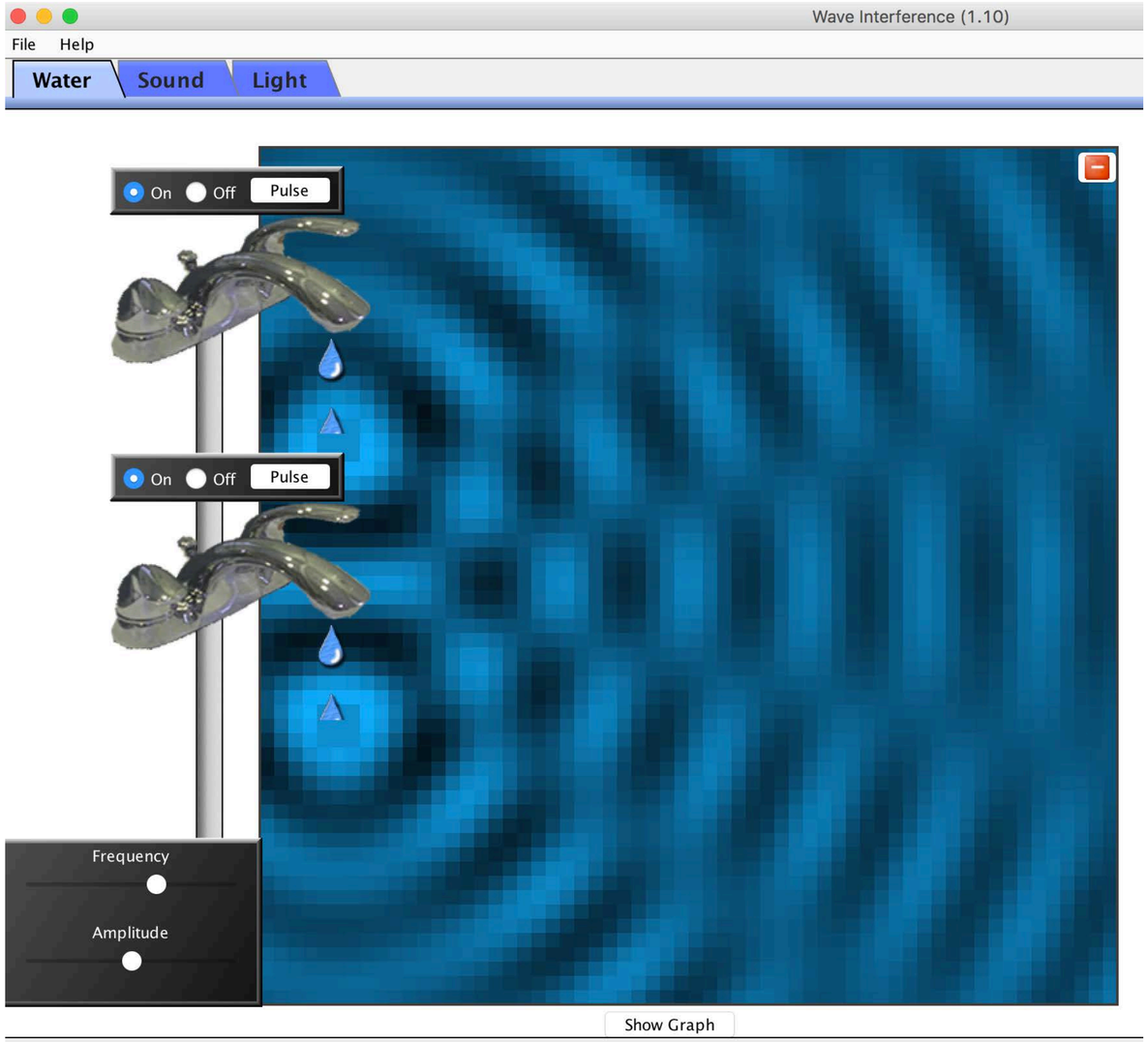


What is Quantum?

One wave

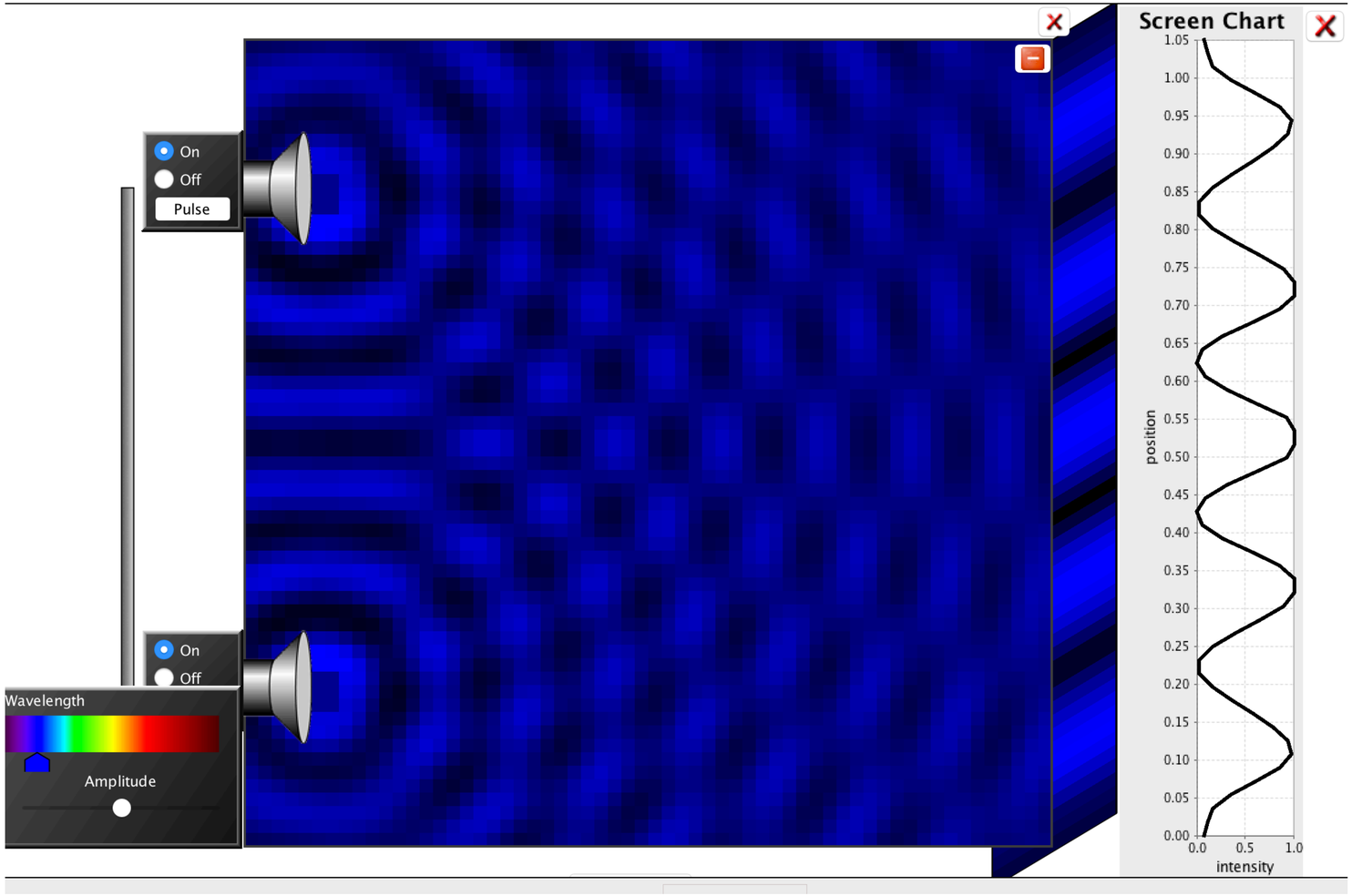


Two waves: interference

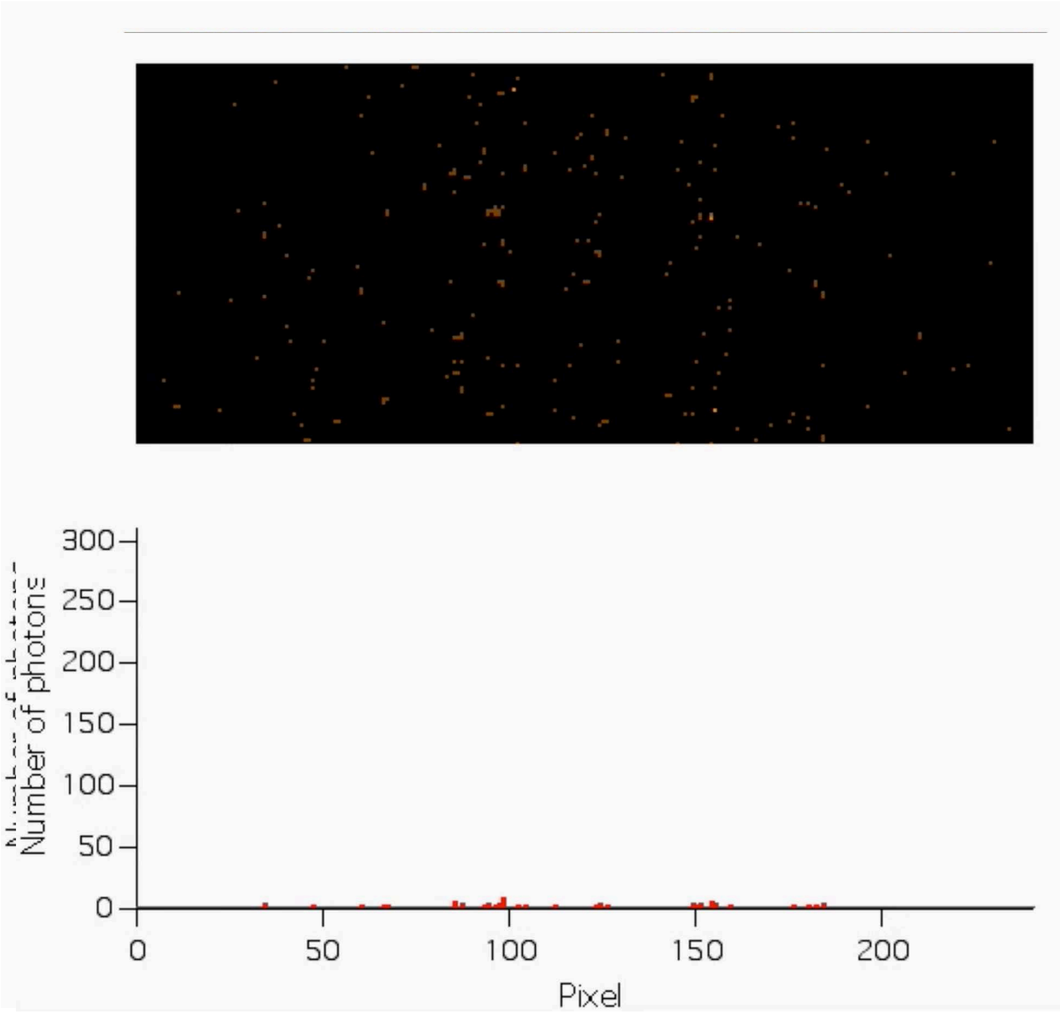


Waves and particles: LIGHT

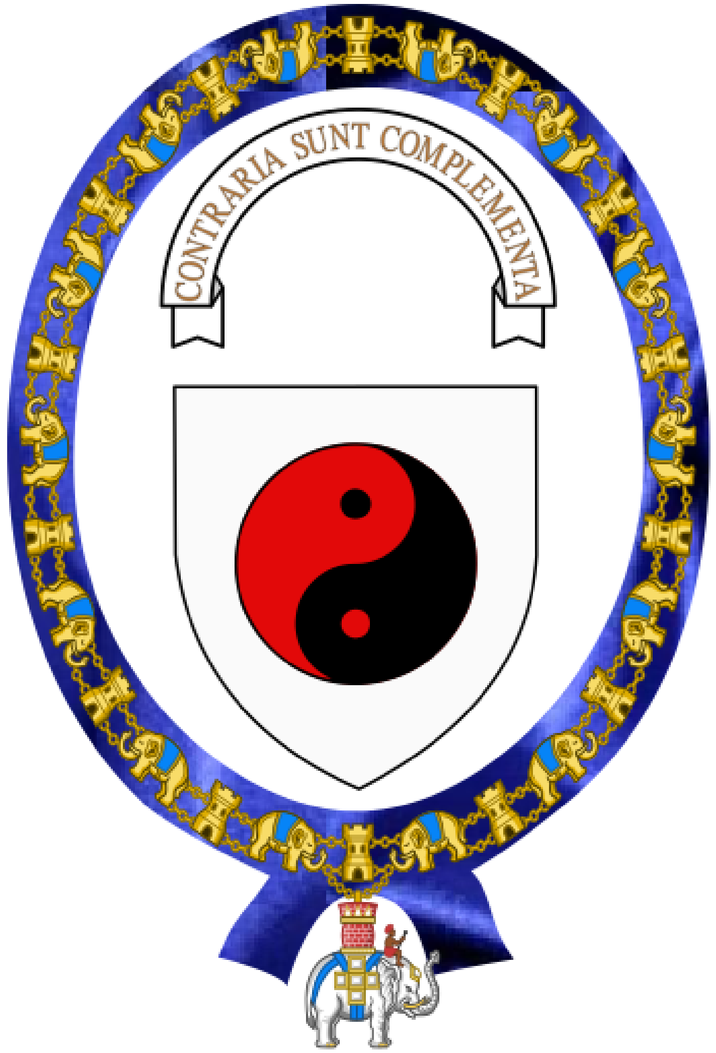
Light interference

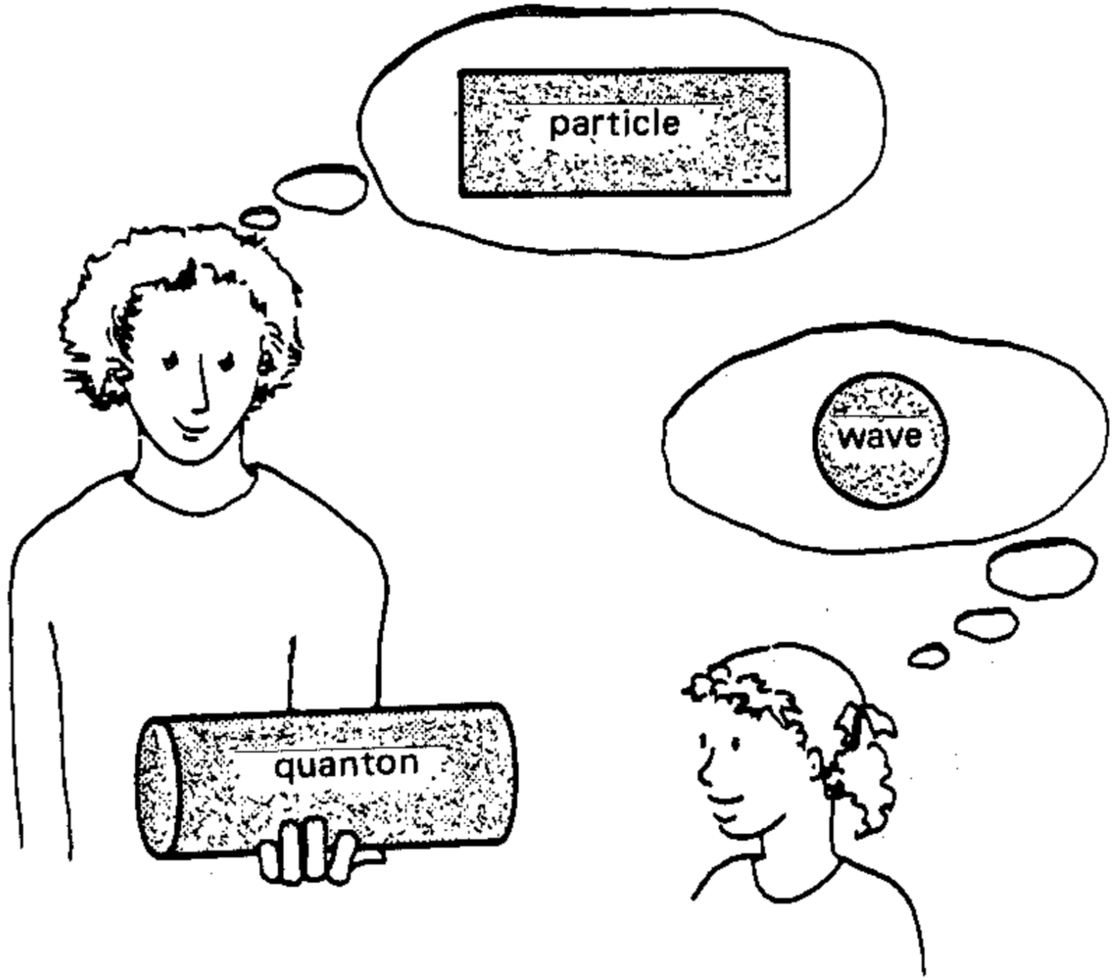


Photon by photon?



Wave and Particle: The Tao of Niels Bohr





from: J.M. Lévy-Leblond & F. Balibar, "Quantics"

"If you think you understand quantum..." [Feynman]

(from: J.M. Lévy-Leblond)

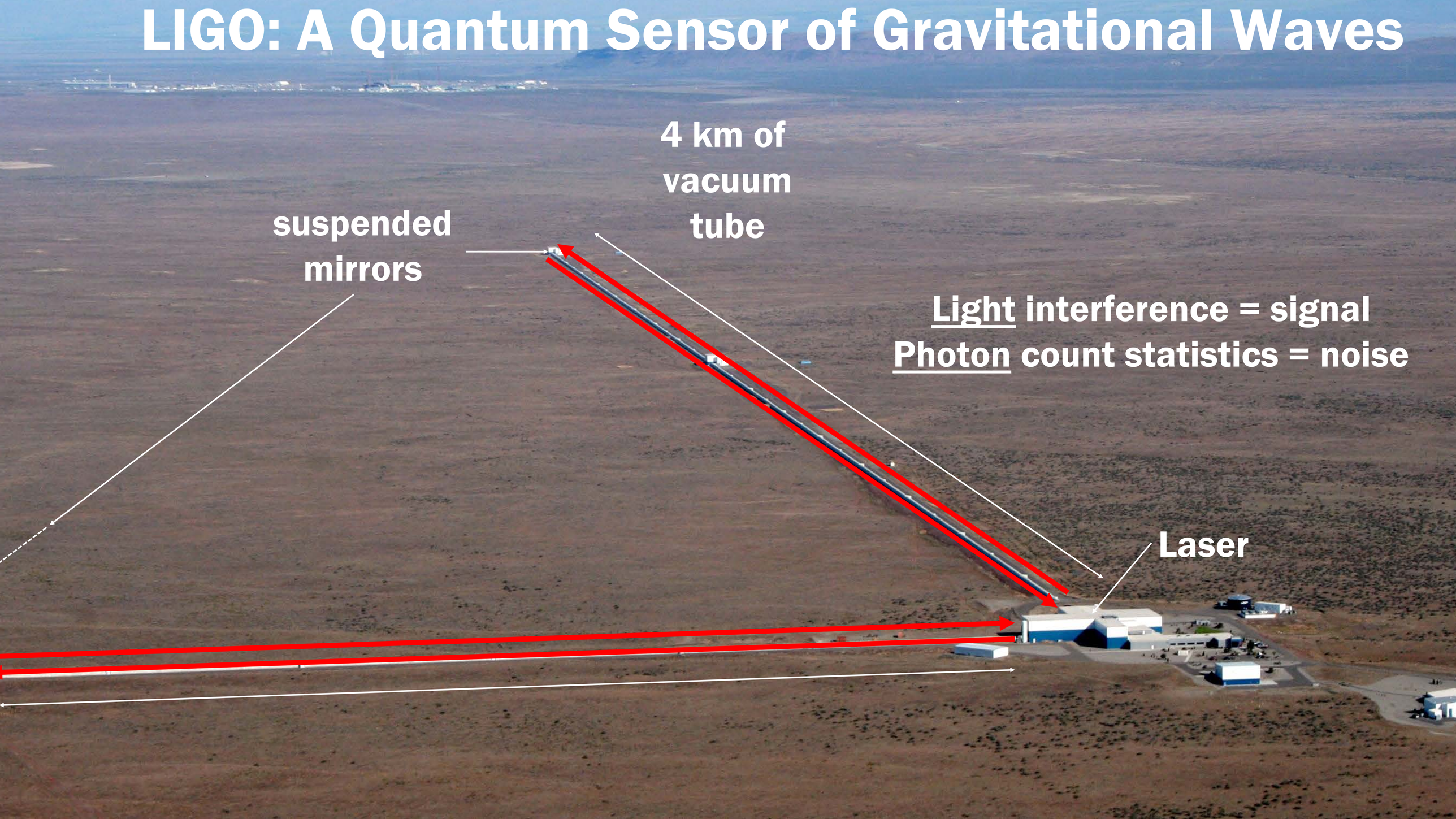
Platypus 😆 (ThinQ!)

Fox?

Duck?

(from: J.M. Lévy-Leblond)

LIGO: A Quantum Sensor of Gravitational Waves



Quantum Computing? A Story of Quantum Bits

$$|0\rangle + |1\rangle$$

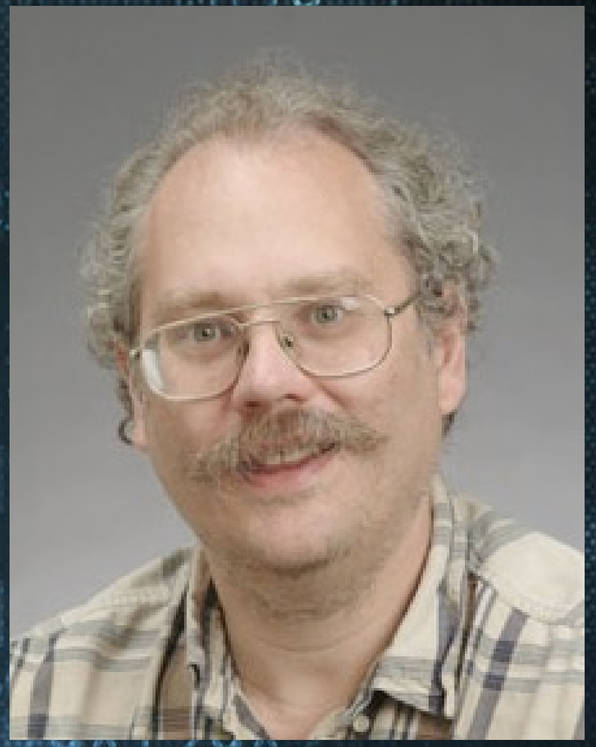
$$\cos\theta|0\rangle + \sin\theta e^{i\varphi}|1\rangle$$

$$|0\rangle - |1\rangle$$

$$|0\rangle \pm |1\rangle$$

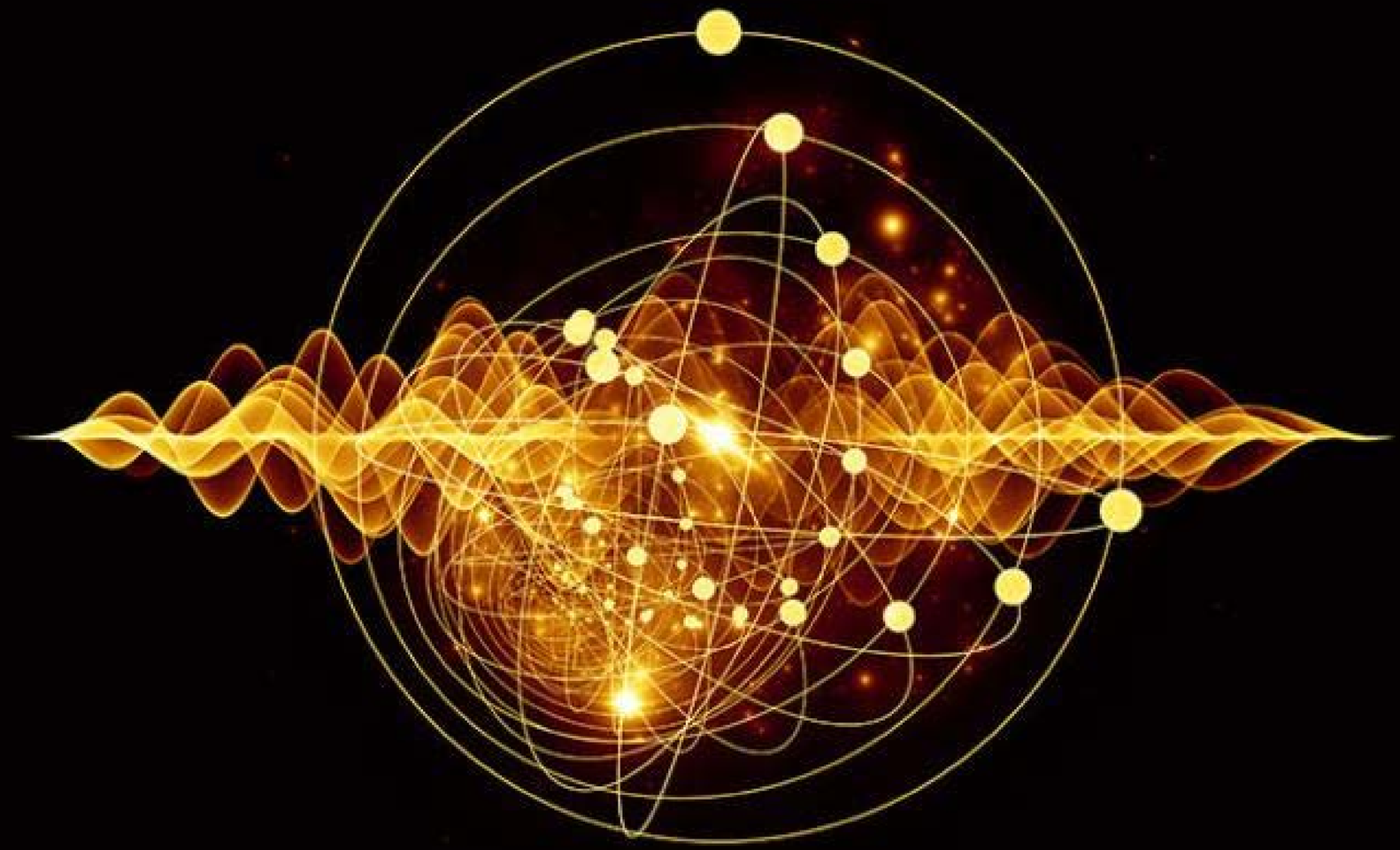
Quantum computers promise exponential speedup

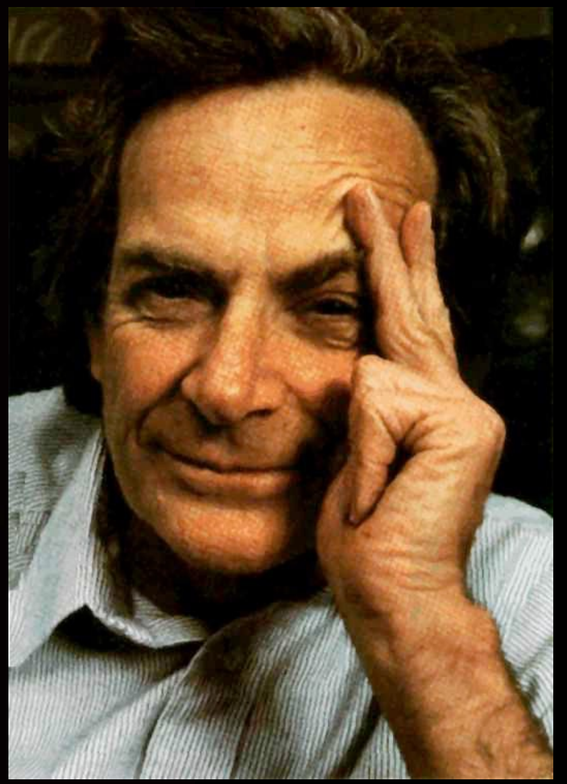
For National Security



Peter Shor (1994)
Breaking RSA encryption

For Simulating Quantum Systems





Richard Feynman (1982)

Quantum Materials: Room-T superconductors

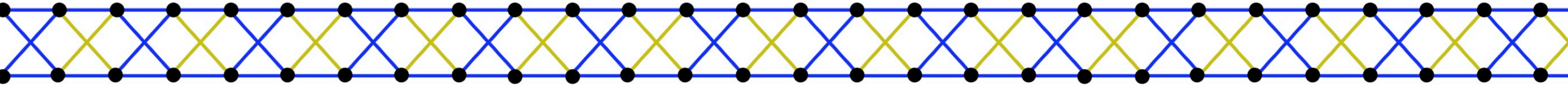
Quantum Chemistry: Efficient Nitrogen fixation. Carbon sequestration

Biology and Medicine: Protein folding. Brain models. Drug Discovery

A Real Quantum Computer

- doesn't exist (yet)
- requires "clean" (error-free) qubits...

... LOTS of them



Integrated Electronics

We crammed billions of these

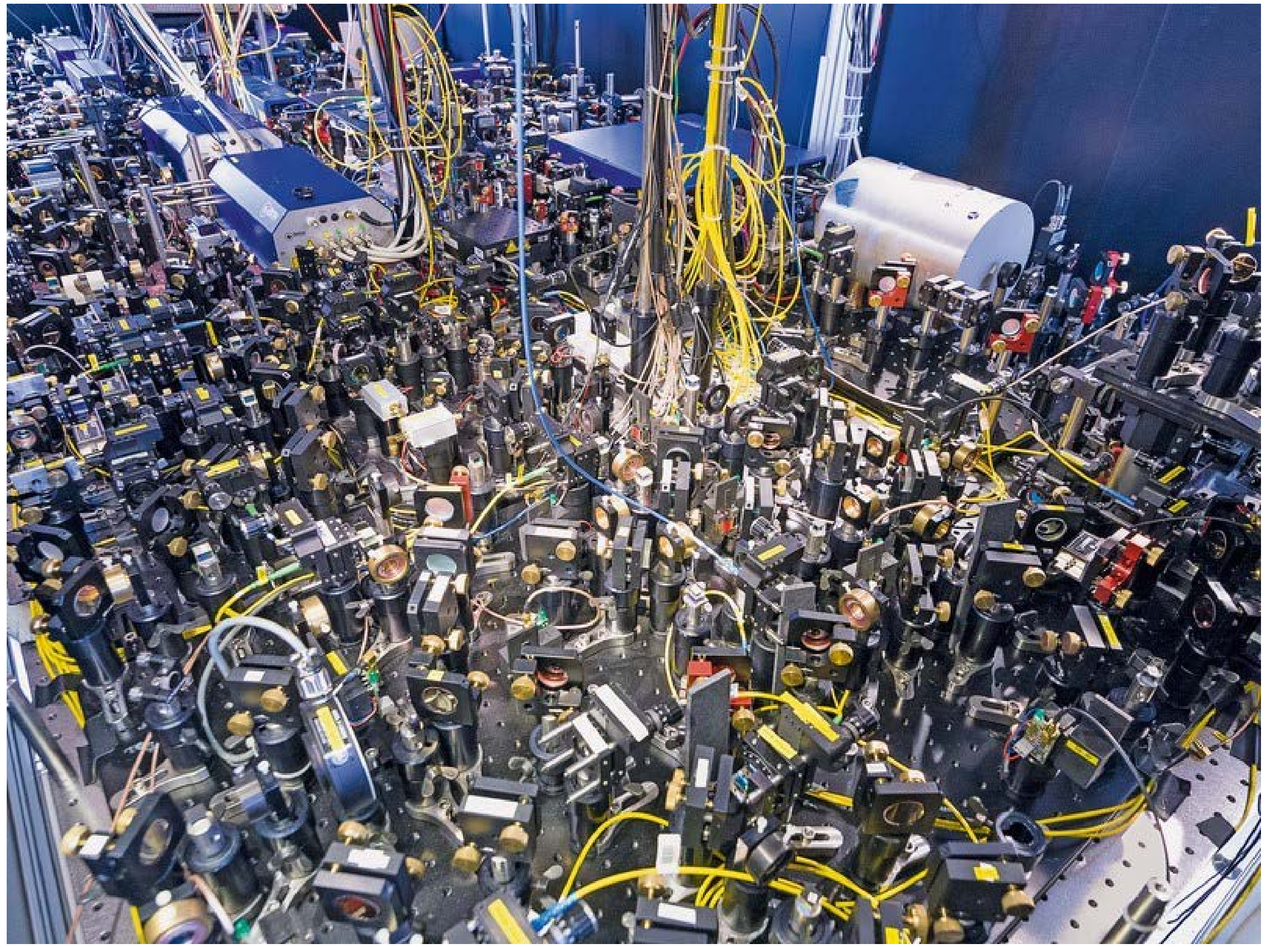
1956 Nobel Prize

into this

2000 Nobel Prize

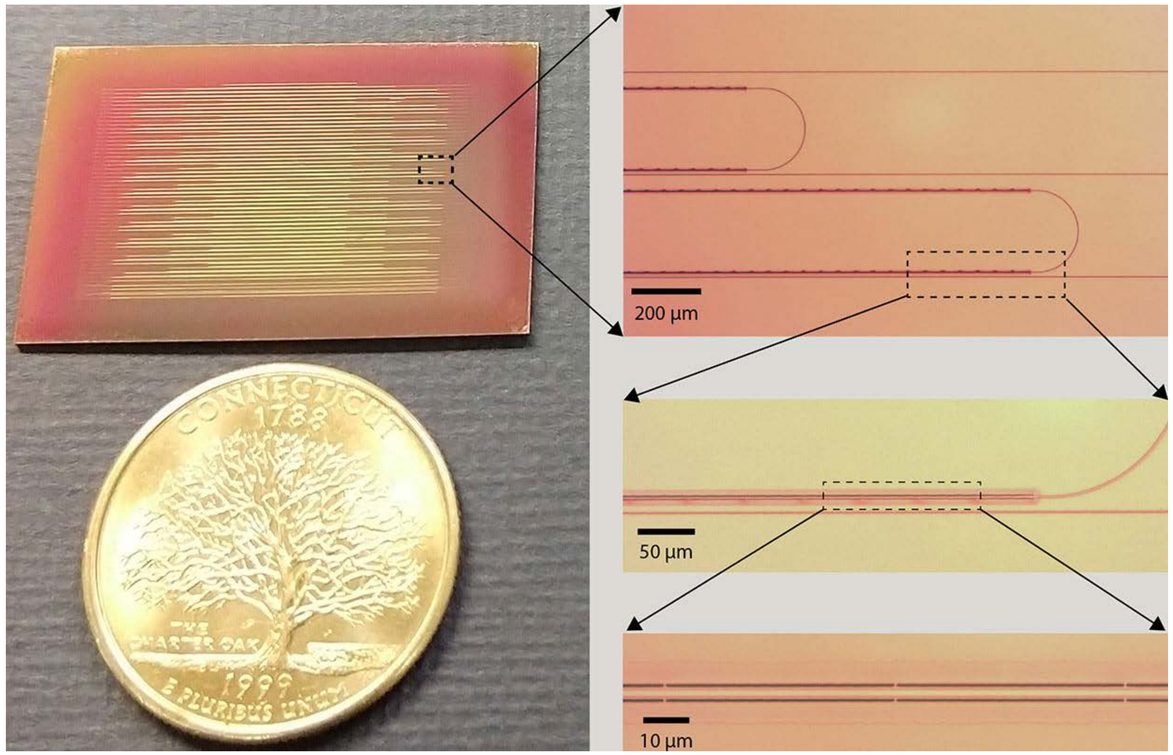
Quantum Photonics

Can we cram a lot of these



Max Planck Institute of Quantum Optics

into this?



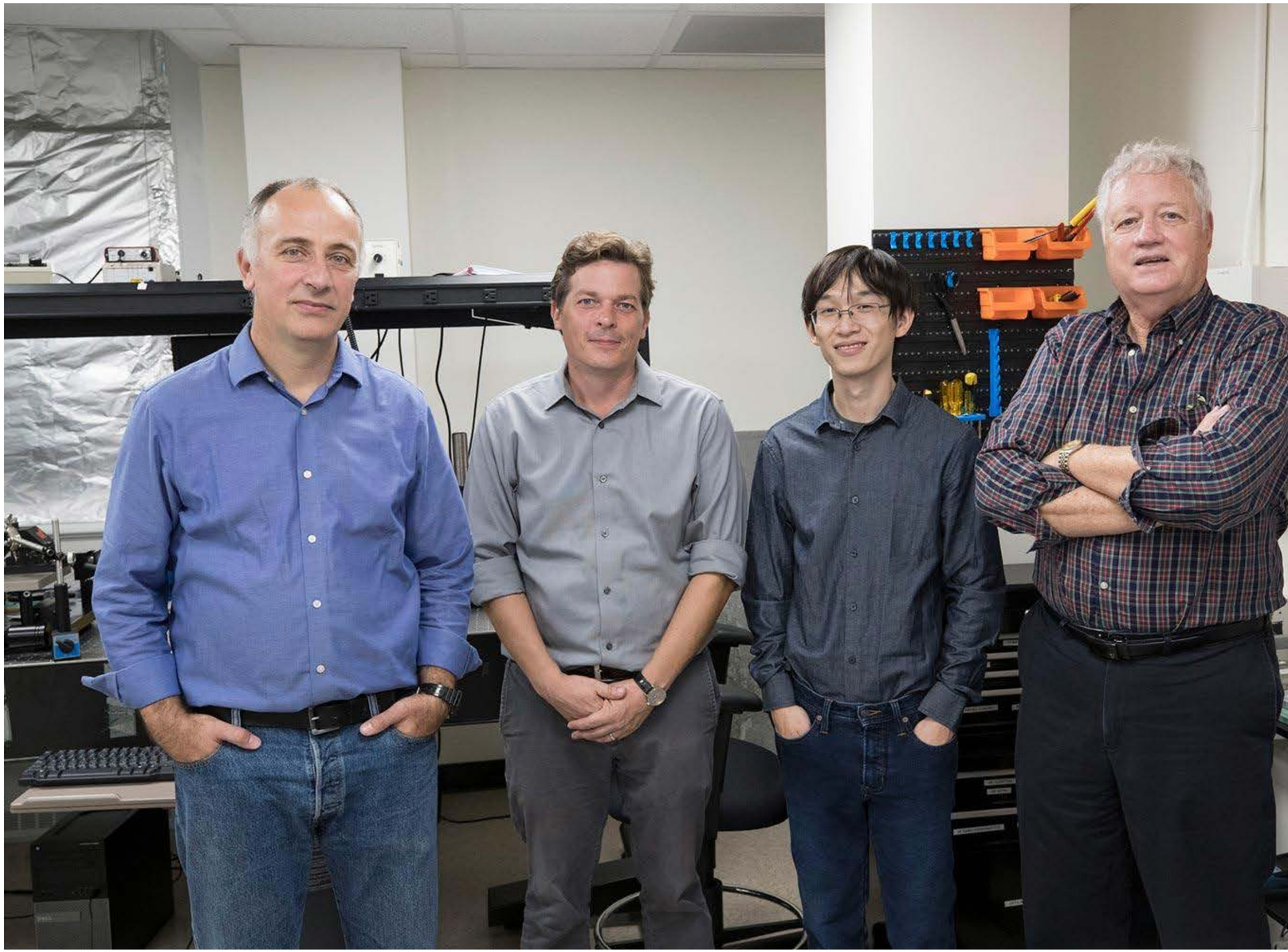
Nils Otterstrom/Yale/AAAS

Quantum Engineering

TRANSDISCIPLINARY

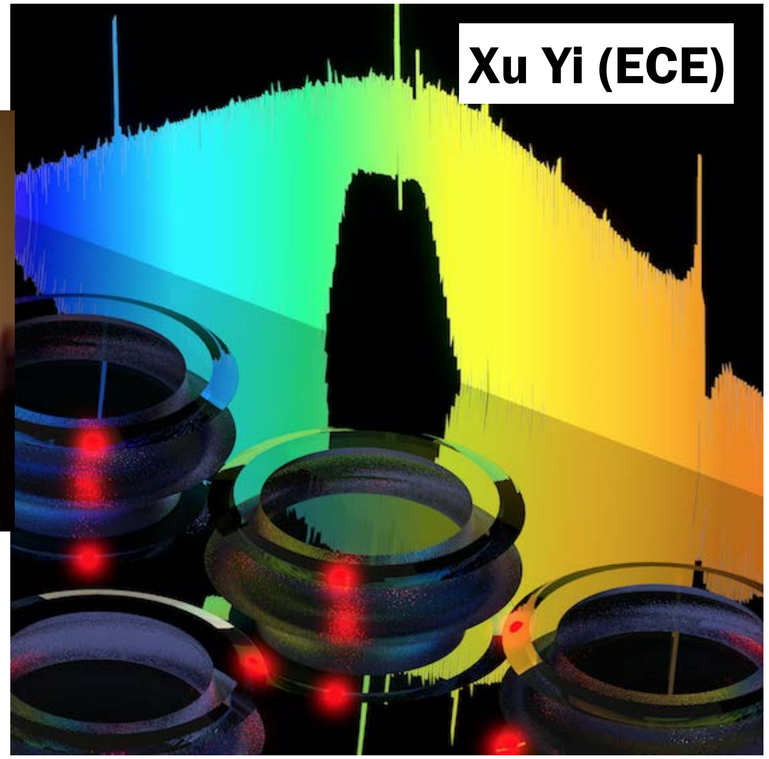
CONVERGENT

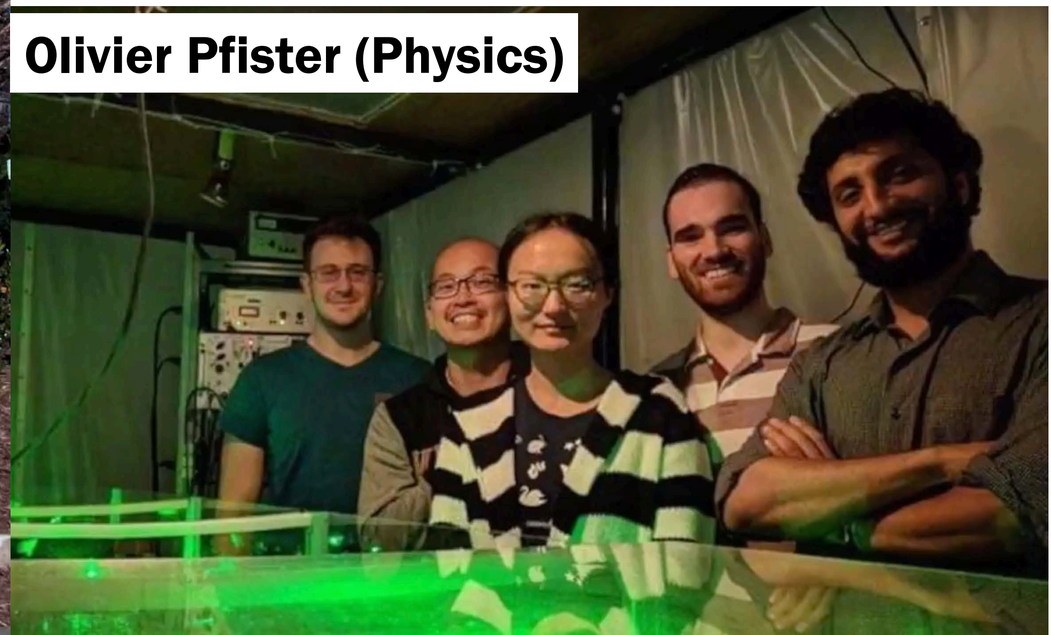
(NSF's words)



Quantum Photonics at UVA

~$2.5M
(Just won
3 NSF RAISE)
6 postdocs
18 grads





Final Thoughts

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