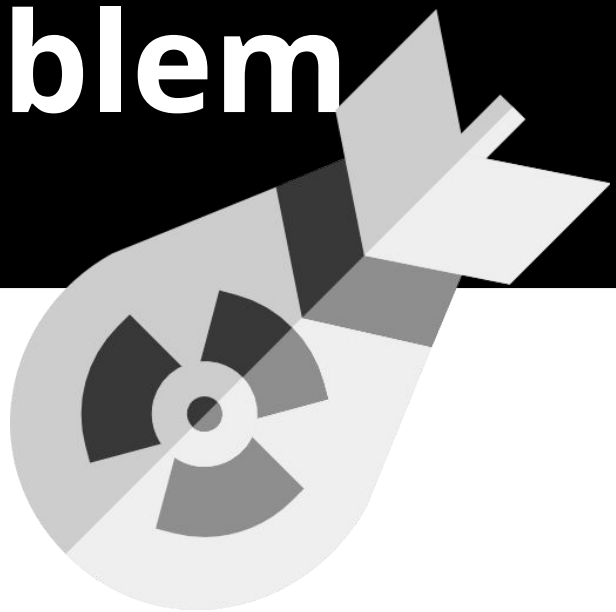
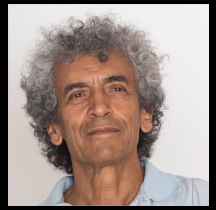
Elitzur and Vaidman bomb testing problem



Vinícius Pereira Pinto
FCM/GO - IFSC/USP



School of Physics and Astronomy,
Tel-Aviv University

Is it possible to make a measurement in a region of space without interacting with it?

School of Physics and Astronomy,
Tel-Aviv University

Quantum Mechanical Interaction-Free Measurements

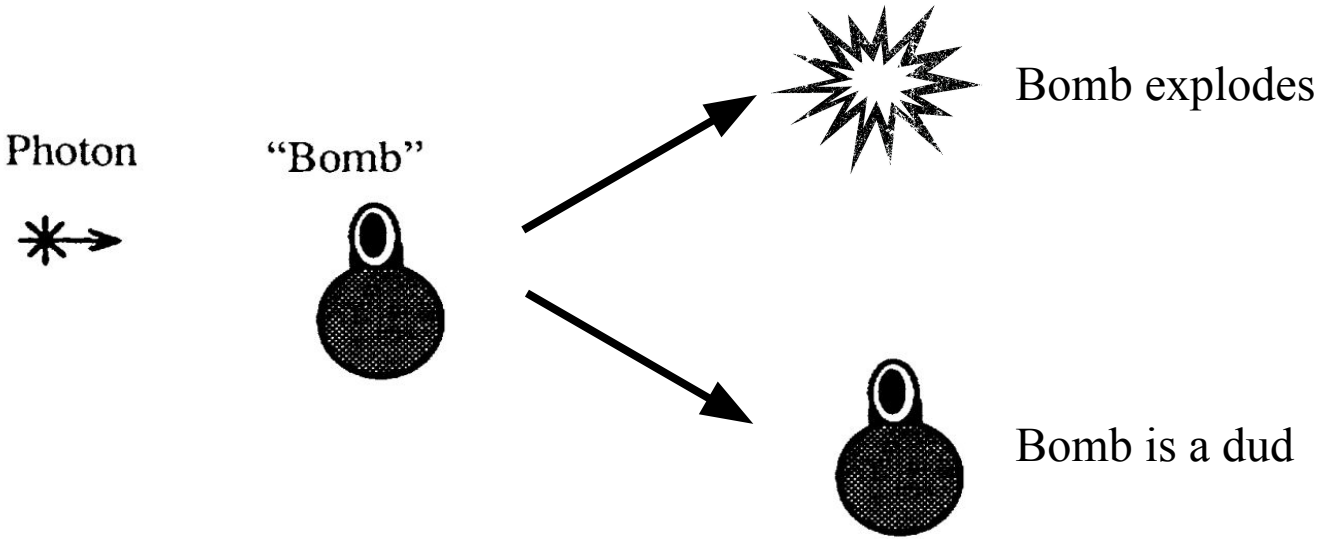
Avshalom C. Elitzur[1,2] **and Lev Vaidman**[1]

Received August 17, 1992; revised January 2, 1993

A novel manifestation of nonlocality of quantum mechanics is presented. It is shown that it is possible to ascertain the existence of an object in a given region of space without interacting with it. The method might have practical applications for delicate quantum experiments.

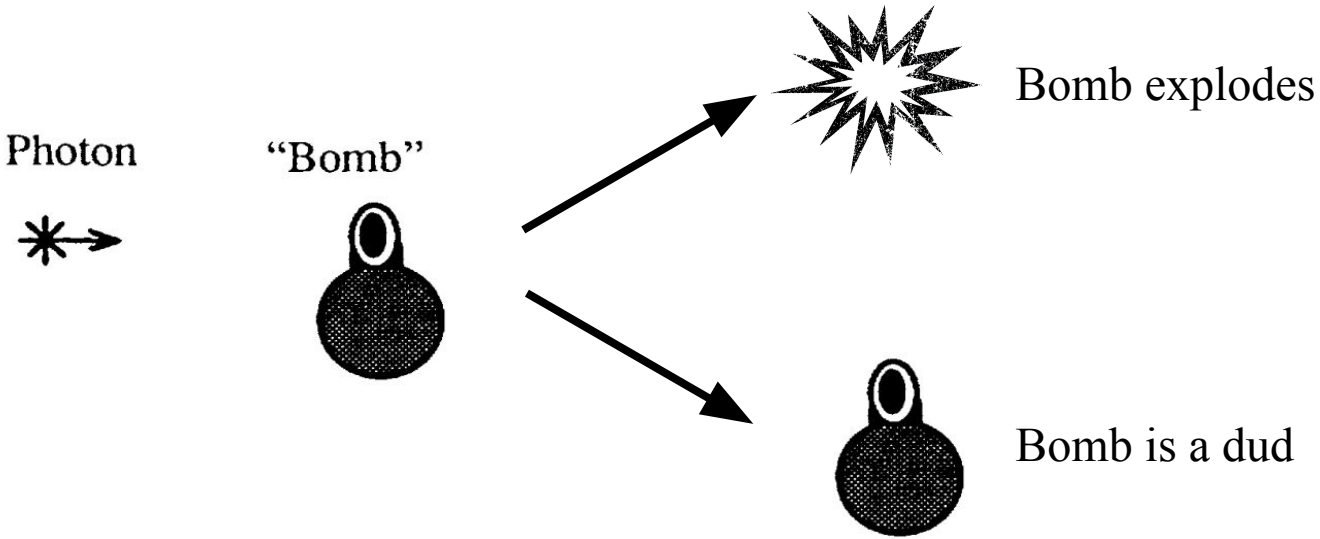
Foundations of Physics ***23***: 7 (1993)

The Elitzur and Vaidman bomb testing problem



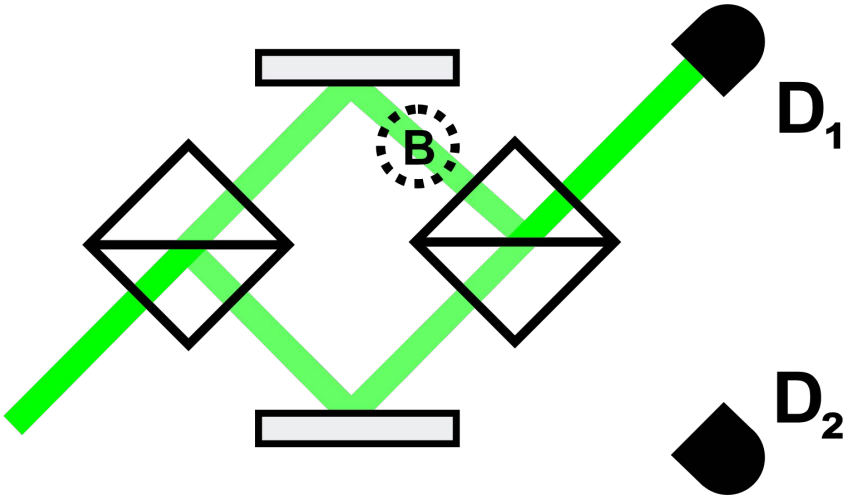
Foundations of Physics ***23***: 7 (1993)

How to test if the bomb works or is a dud without interacting with it?



Foundations of Physics ***23***: 7 (1993)

The Elitzur and Vaidman bomb testing proposal:



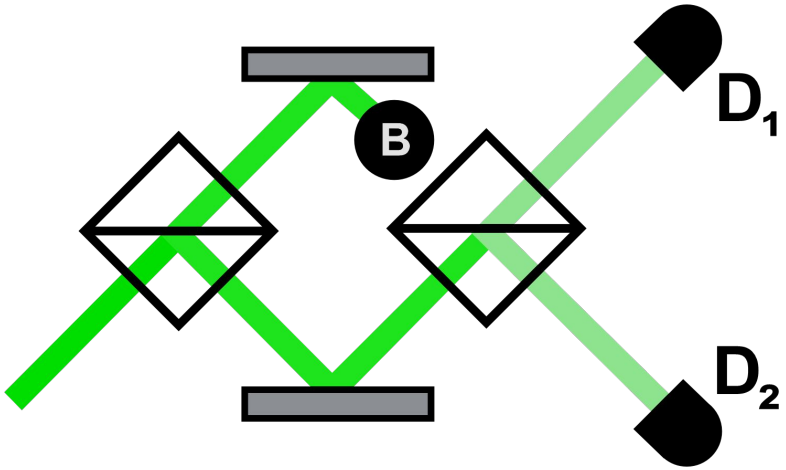
Mach-Zender Interferometer

$|1\rangle$ D1 clicks, probability = 1

$|2\rangle$ D2 clicks, probability = 0

Foundations of Physics ***23***: 7 (1993)

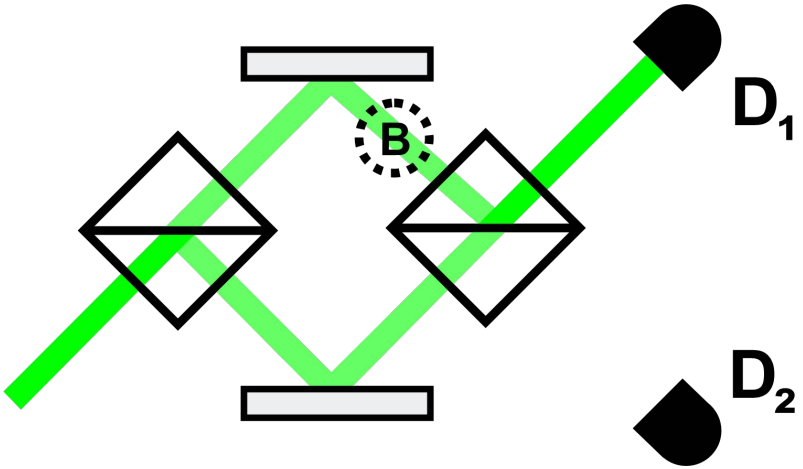
The Elitzur and Vaidman bomb testing proposal:

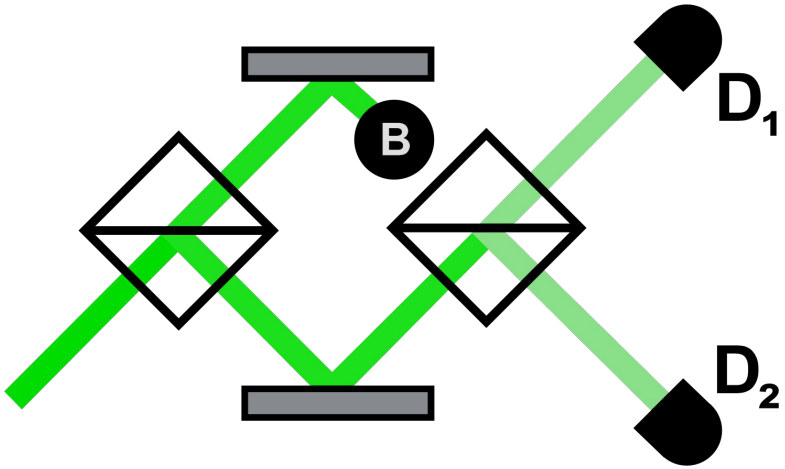


$$\begin{cases} |1\rangle, & \text{D1 clicks, probability} = 1/4 \\ |2\rangle, & \text{D2 clicks, probability} = 1/4 \\ |s\rangle, & \text{no clicks, probability} = 1/2 \end{cases}$$

Foundations of Physics ***23***: 7 (1993)

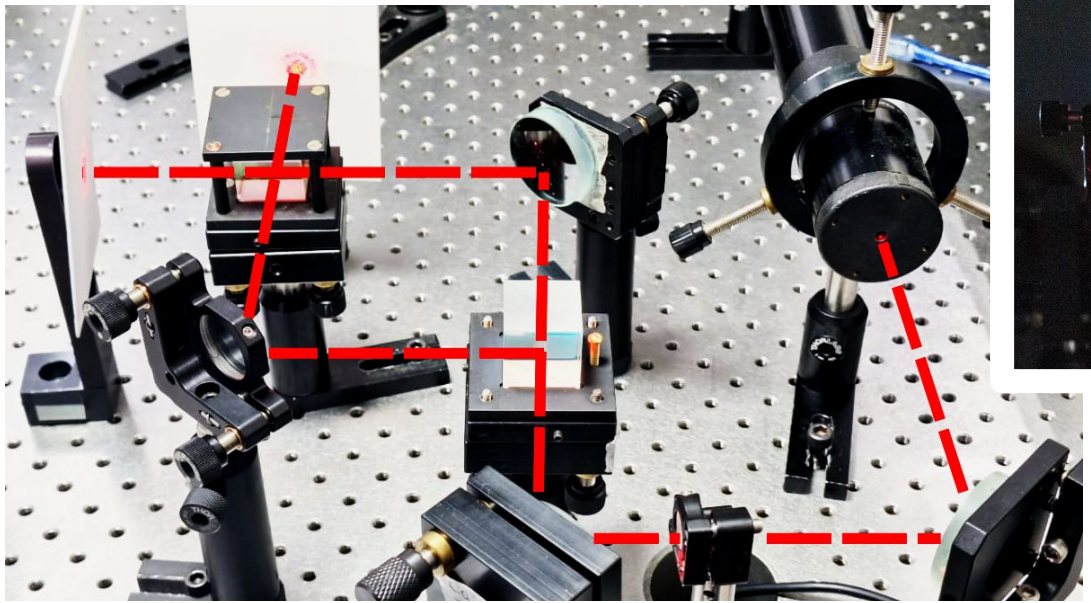
Detector D2 only clicks when the bomb works

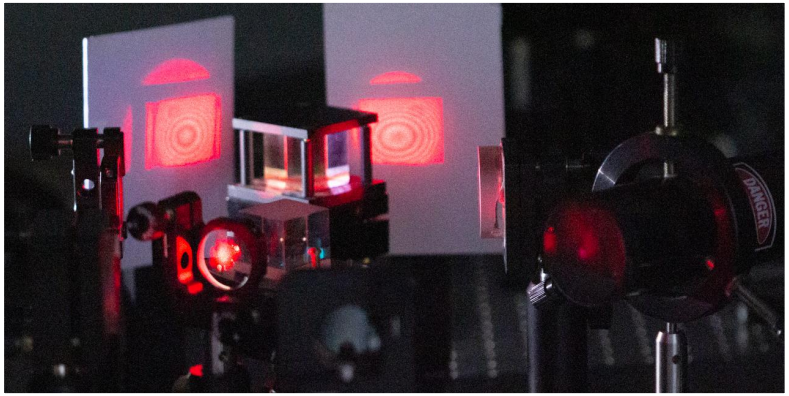




Foundations of Physics ***23***: 7 (1993)

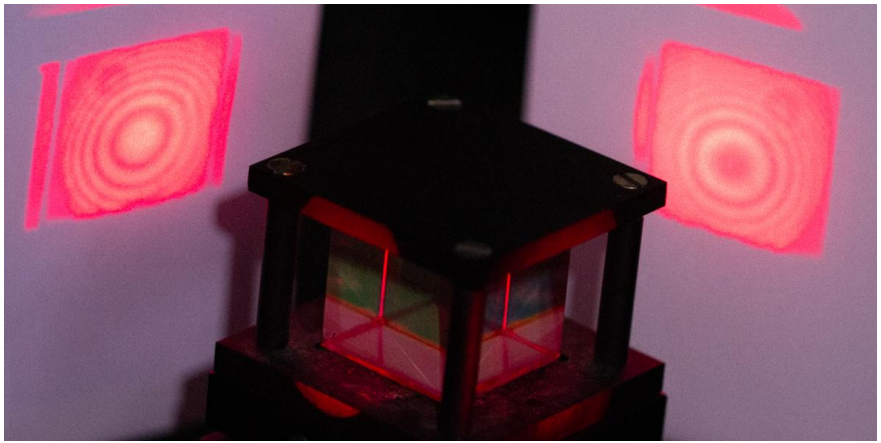
Reproduction of the Elitzur and Vaidman bomb testing proposal:



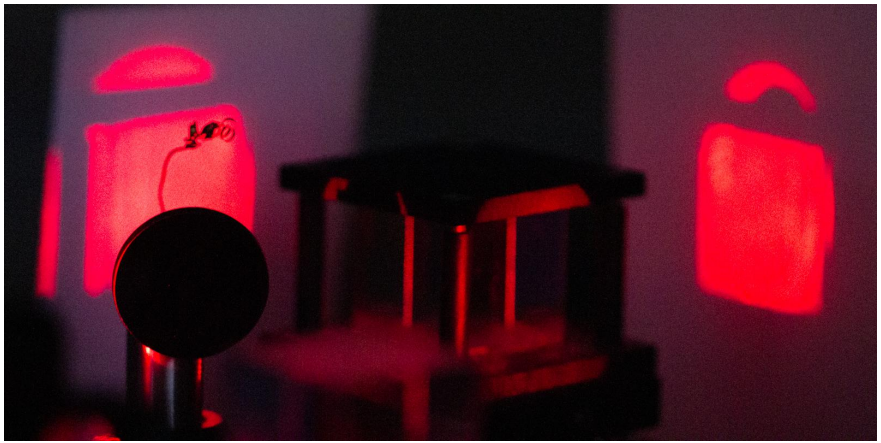


Reproduction of the Elitzur and Vaidman bomb testing proposal:

Without the bomb



With the bomb



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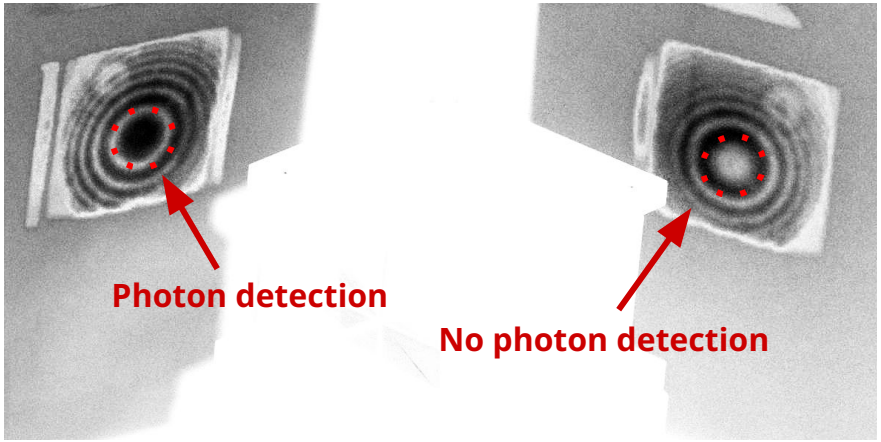
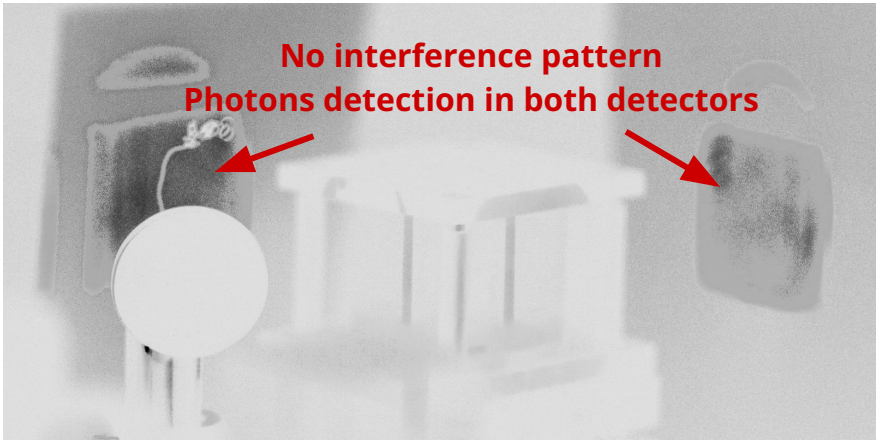
Without the bomb



With the bomb

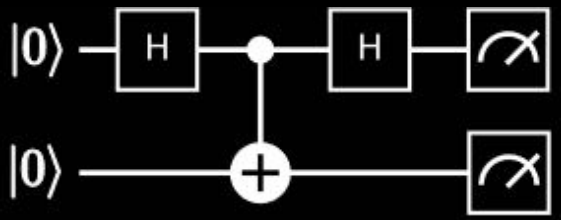


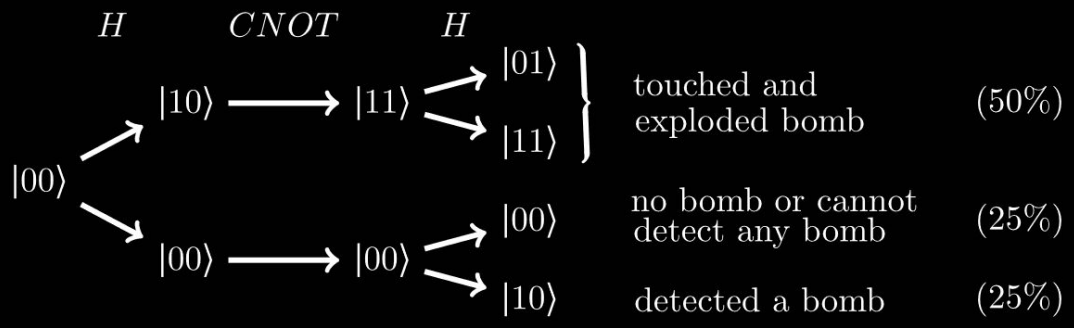
Experimenting quantum phenomena on NISQ computers using high level quantum programming

Duc M. Tran[1], Duy V. Nguyen[2,3], Bin Ho Le[4,5] and Hung Q. Nguyen[1*]

EPJ Quantum Technology
a SpringerOpen Journal

EPJ Quantum Technology **9**: 6 (2022)





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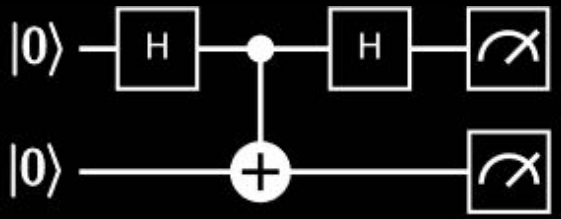

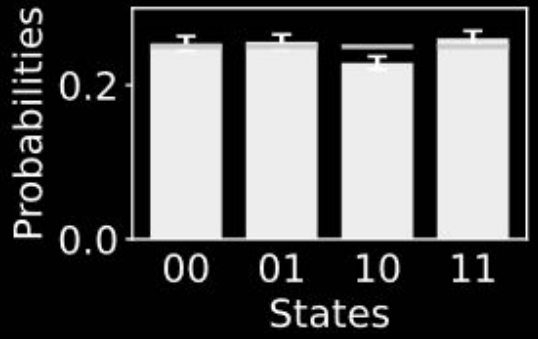

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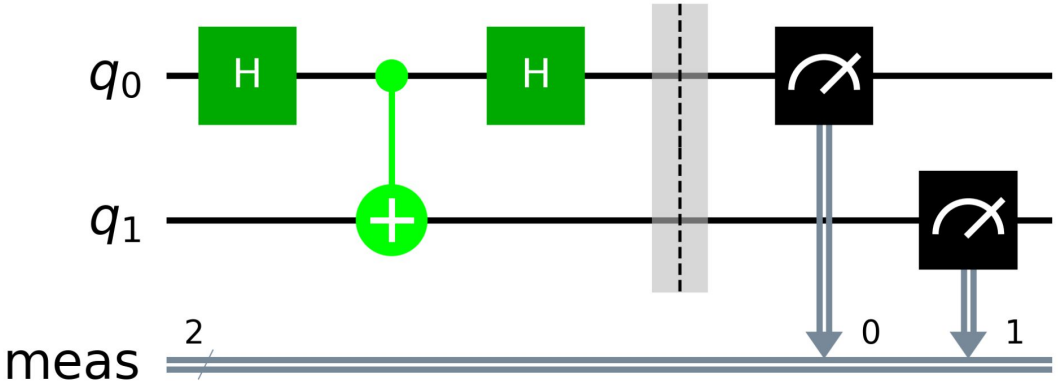
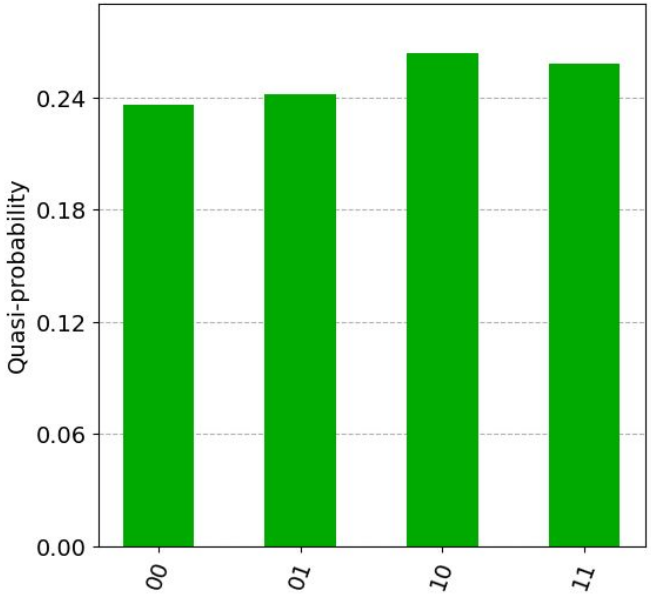




Is it possible to know if the bomb works without exploding it 50% of the time?

Interaction-Free Measurement

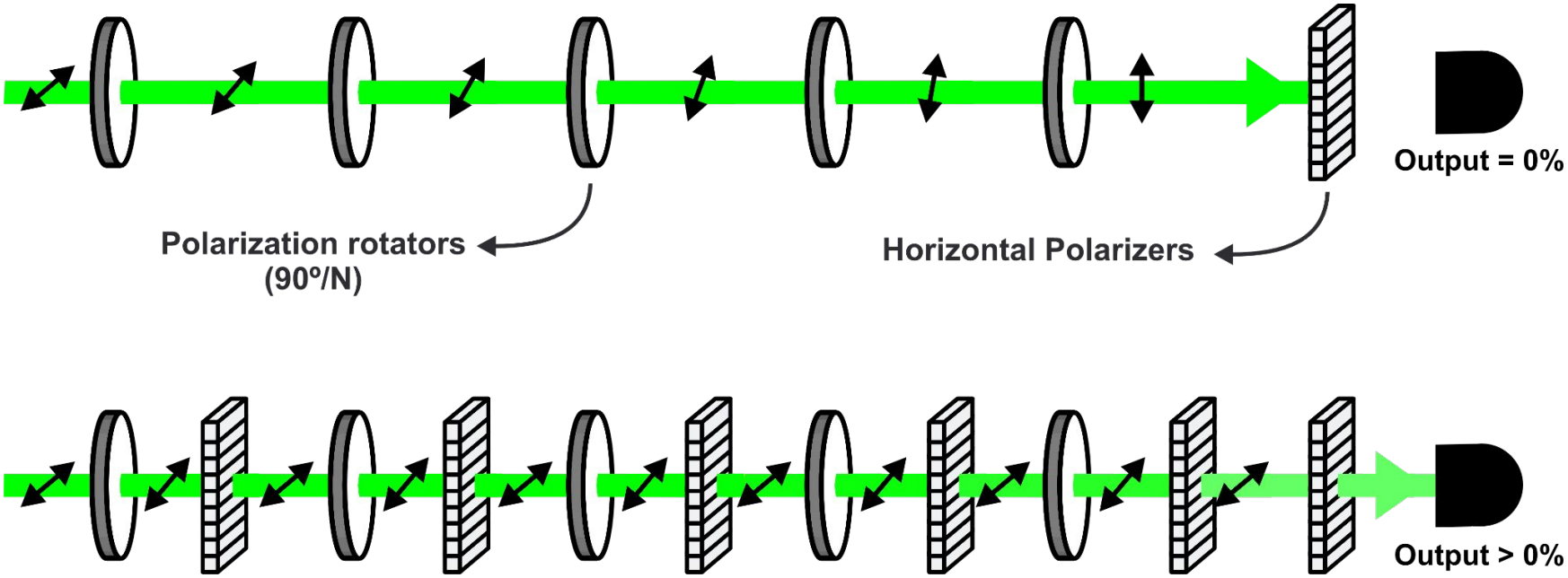
Paul Kwiat, Harald Weinfurter, Thomas Herzog, and Anton Zeilinger
Institut für Experimentalphysik, Universität Innsbruck, Technikerstrasse 25, 6020 Innsbruck, Austria

Mark A. Kasevich
Department of Physics, Stanford University, Stanford, California 94305
(Received 19 September 1994)

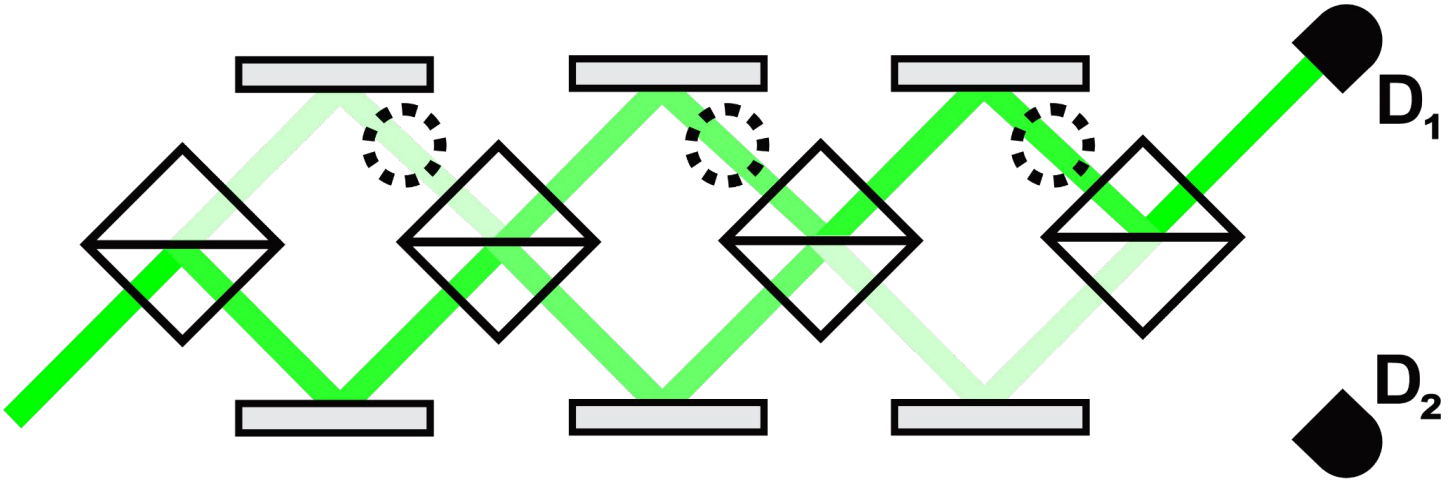
We show that one can ascertain the presence of an object in some sense without interacting with it. One repeatedly, but weakly, tests for the presence of the object, which would inhibit an otherwise coherent evolution of the interrogating photon. The fraction of "interaction-free" measurements can be arbitrarily close to 1. Using single photons in a Michelson interferometer, we have performed a preliminary demonstration of some of these ideas.

Physical Review Letters ***74****:* 24 (1995)

Quantum Zeno Effect



Interaction-Free Measurement through Quantum Zeno Effect



Physical Review Letters ***74****:* 24 (1995)

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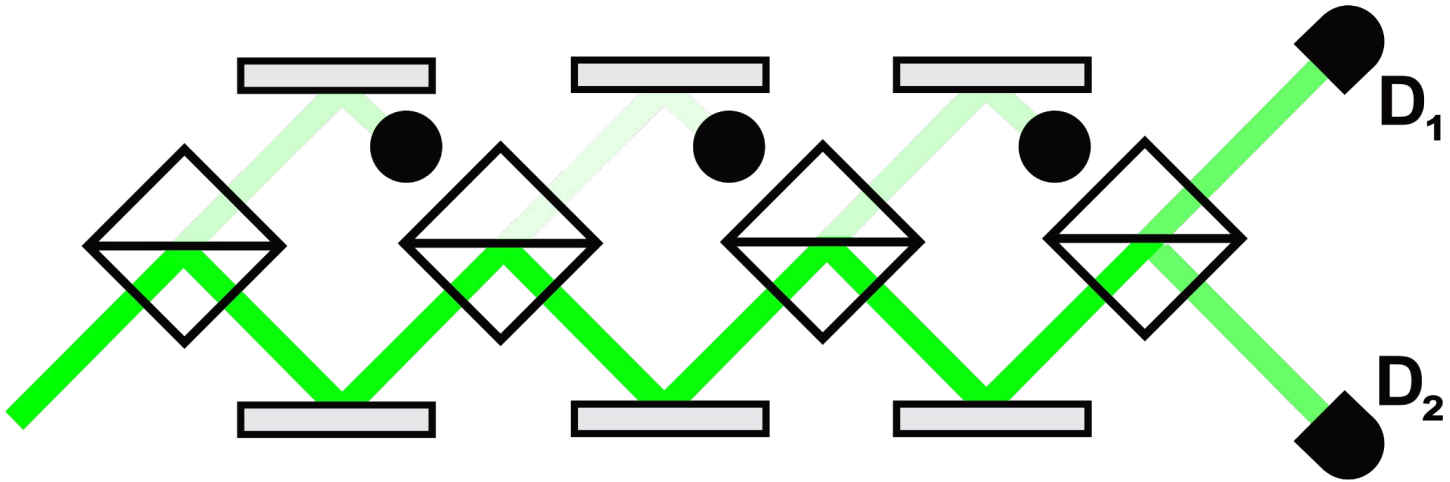
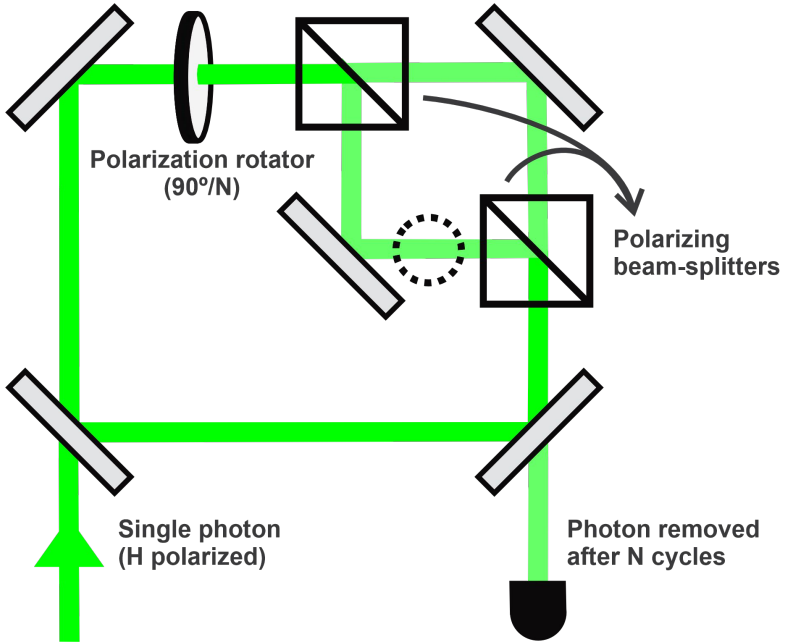


Physical Review Letters ***74****:* 24 (1995)

Interaction-Free Measurement through Quantum Zeno Effect for a single bomb



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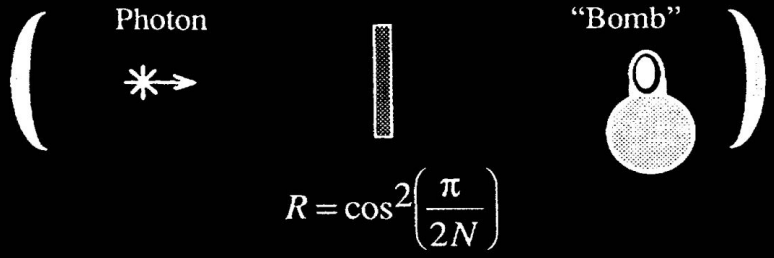

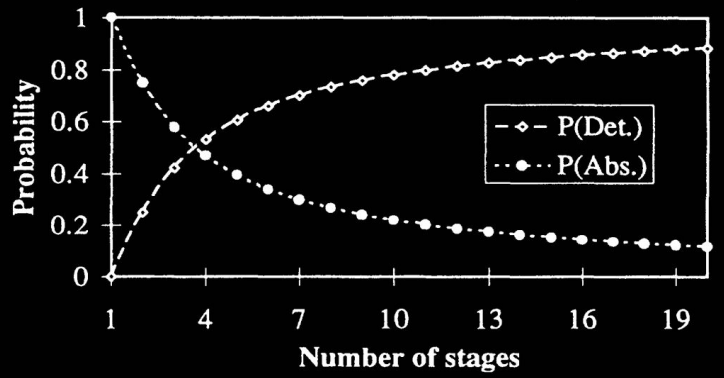

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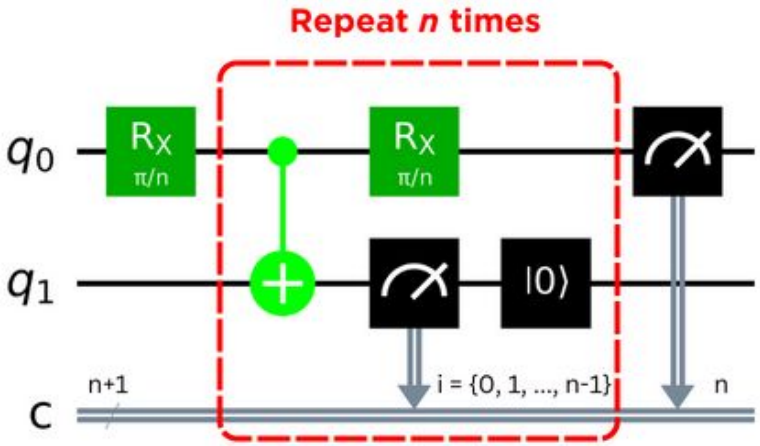

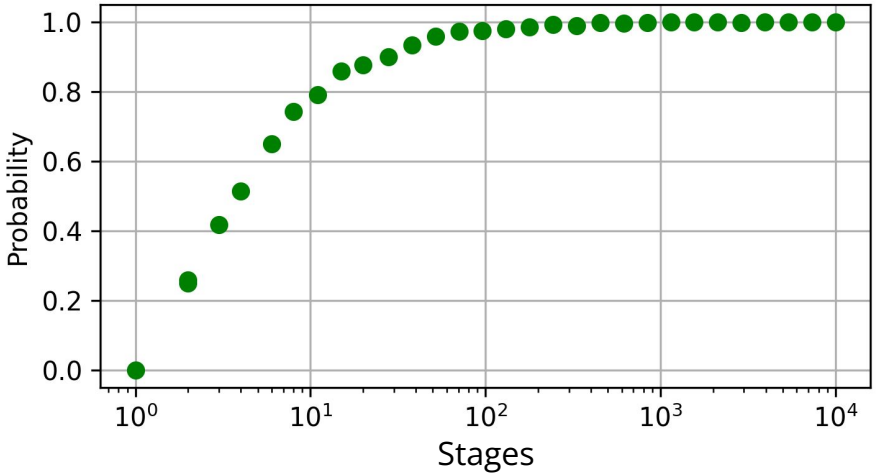

Single real result

It is possible to obtain a result without direct interaction

There is a nonlocal correlation between the state of the object and the result in the detector (nonlocality does not transmit information faster than the speed of light)

Hidden variables

Hidden variables that interact with the bomb determine the trajectory of the particle

Many-worlds interpretations

The photon always interacts with the bomb, but not necessarily in this universe

universe A

universe B

References

Elitzur, Avshalom C.; Lev Vaidman. "Quantum mechanical interaction-free measurements". *Foundations of Physics*, **23** (7): p. 987–997 (1993).

Kwiat, P. G. ; Weinfurter, H.; Herzog, T.; Zeilinger, A.; Kasevich, M. A. "Interaction-free Measurement". *Phys. Rev. Lett*., **74** (24): p. 4763–4766 (1995).

Tran, D. M.; Nguyen, D. V.; Le, B. H.; Nguye, H. Q. "Experimenting quantum phenomena on NISQ computers using high level quantum programming", *EPJ Quantum Technology* **9**: 6 (2022)

McQueen, K. J.; Vaidman, L., "In Defence of the Self-Location Uncertainty Account of Probability in the Many-Worlds Interpretation". *Studies in History and Philosophy of Science*, **66**: p. 14–23, (2019).