

## Are photons fundamental and indivisible?

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### Abstract:

An experiment is described and illustrated that may show that ordinary measurable photons are not fundamental/indivisible particles and rule out the non locality (and interaction free measurement) due to superposition of photons. Arrangements of Mach-Zehnder Interferometer apparatus are proposed for the investigation. Division at a half silvered mirror, into a part still detectable as a photon particle, the cut photon body, and a sub photon member is hypothesized. Three possible outcomes are described. Two of them support the notion of actual physical photon divisibility. One of the outcomes is not supportive of the notion. Some supplementary experiments are given for further investigation according to the outcomes found. Hope is expressed that this investigation is conducted by many institutions, so there is widespread consensus on the nature of photons. It is also hoped that this becomes a standard demonstration of that nature, whatever outcome is found.

### Question:

Is a photon that has encountered a half silvered mirror and not been reunited by path joining, conjectured to be a cut photon body *1. divisible* into all non detectable members, *2. divisible* into a detectable and an undetectable part like an entire photon or *3. fundamentally different* from an entire photon in its *indivisibility*.

### Hypothesis:

Photon divisibility is proposed. Half silvered mirrors are able to divide photons into a detectable portion, detected as a particle. That particle is still called a photon despite having undergone 'amputation'. For clarity it shall be called a cut photon body Also a sub detectable portion is formed having wave like character. Which will be called a sub-photon member. Identified by causing wave-like interference when recombined with the portion it was split from (the cut photon body). The sub-photon member is an existing element of noumenal Object reality. Source of the phenomenon observed indicating wave interference has happened. This can explain observed outcomes, rather than needing to use superposition for explanation. Both an entire photon and a cut photon body are detected as if the same; a photon.

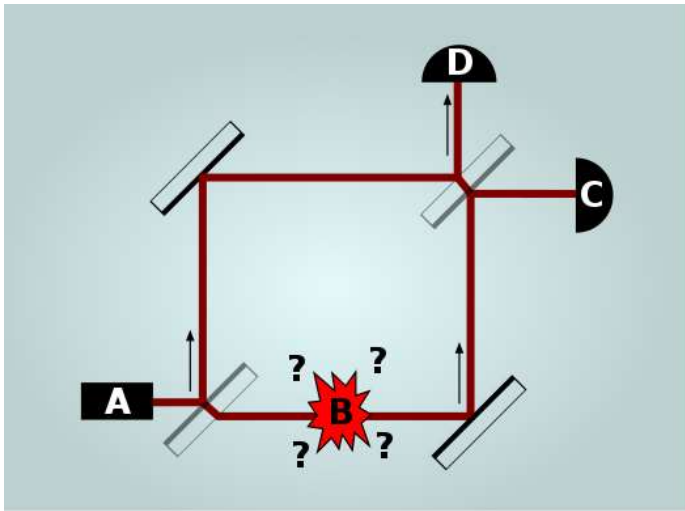
### Demonstration: The hypothesis used for explanation:

**[Elitzur–Vaidman bomb tester](#)** This (Wikipedia) link gives background and conventional explanation.

This contraption uses a photon sensitive bomb. If live, detection of a photon causes detonation. If dud the photons pass through unhindered and undetected. Only an entire (un-split) photon or detectable portion from silver mirror photon splitting is able to detonate a bomb. An undetectable but existing 'amputated' part (photon member) can pass through a dud bomb and be stopped by a live bomb, but not detonate it.

## The apparatus

[https://en.wikipedia.org/wiki/ElitzurE2%80%93Vaidman\\_bomb\\_tester#/media/File:E-V\\_bomb-testing\\_2.svg](https://en.wikipedia.org/wiki/ElitzurE2%80%93Vaidman_bomb_tester#/media/File:E-V_bomb-testing_2.svg) 17<sup>th</sup> Sept 2019



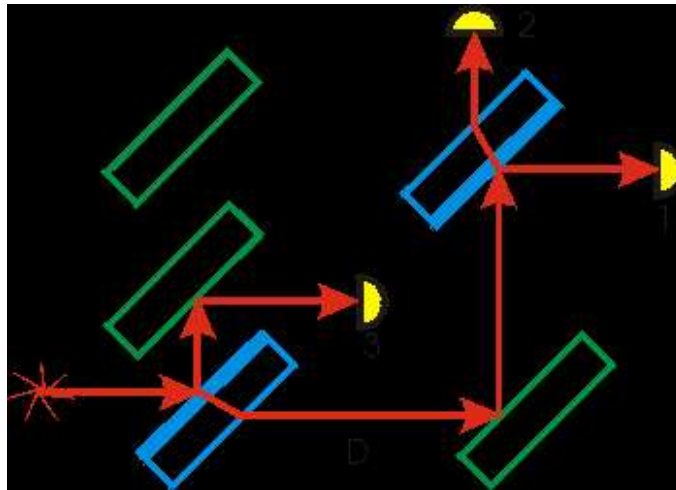
After another half-silvered mirror there are two detectors C and D. C is positioned to receive the product of constructive interference. D is positioned to receive the product of destructive interference. Which is not visible. So photons that arrive at Detector C only are detected, if the bomb is a dud; [following photon reunion and interference.]. For an un-*exploded live bomb*, if just the pre cut photon body arrives at the mirror, via the upper path; *Half of the time* the pre cut photon body goes via the upper path to detector D. [Without Interference with the formerly severed sub-photon member in either case.] *Half of the time* the pre cut photon body goes via the upper path to detector C. If the live bomb explodes the cut photon body took the lower path, no detection is made at C or D.

From this; The photon splitting proposition can be used for prediction and explanation. As an alternative to use of superposition. Explaining experimentally observed outcomes of similar scenarios using detectors other than bombs. It implies that Interaction free detection is a misnomer. As this result relies upon the sub photon member being taken out of 'circulation' at the bomb. So it can not come together with the cut photon body and interfere. That enabling the chance of D detector detection. However it is still necessary to show that actual photon partition occurs; As a noumenal reality rather than abstractly.

## Another experiment explained using the hypothesis

This is the same apparatus as the bomb tester, with some modification. Instead of a bomb in the lower path, another ordinary mirror is placed in the upwards path; deflecting the beam to a new detector. Without the extra mirror in place destructive interference prevents detector D detection. With that mirror in place the sub photon members are prevented from reuniting. So there is no destructive interference, to prevent a visible detection. Photons but not interference can be detected at D. *This can account for what otherwise seems to be a non local effect.* As the lower beam photons do not encounter the new mirror and detector (if they are just ordinary indivisible photons, how do they know how to behave at the detectors without a non local explanation?)

Diagram copied from March 2000 by David M. Harrison, Department of Physics, University of Toronto via [faraday.physics.utoronto.ca/PVB/Harrison/Locality/Locality.html](http://faraday.physics.utoronto.ca/PVB/Harrison/Locality/Locality.html)



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Apparatus:

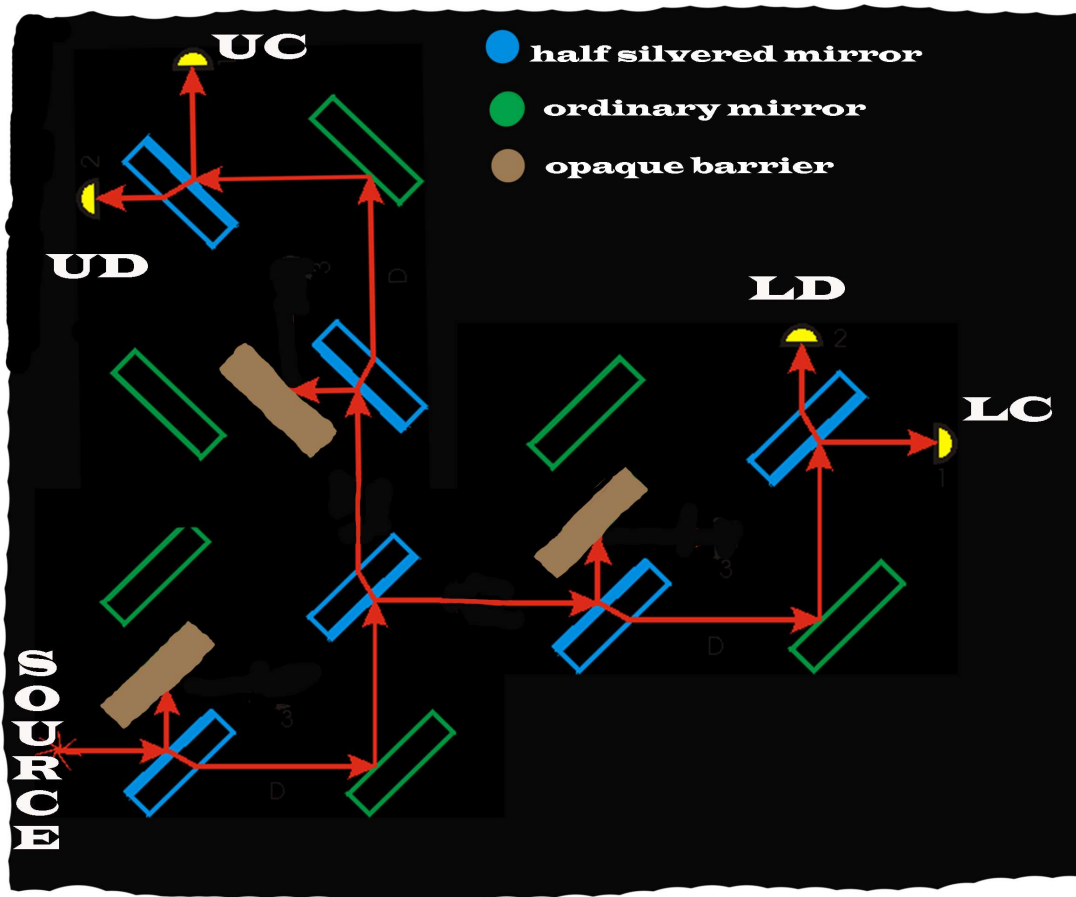
Mach-Zehnder Interferometer apparatus will be used,. A Mach-Zehnder Interferometer is like the bomb tester apparatus without the bomb. The first Mach-Zehnder Interferometer having one path blocked. Any non reflective opaque material optical barrier will do. Such as a wood block. Either the reflected upwards path or the transmitted through the glass path could be blocked. It is reasonable to assume that equal numbers of cut photon bodies and sub photon members take each path. The experiment can be run using each configuration to be sure it is not relevant to the outcome. Showing no preference of path at the half silvered mirror of the kinds of part photons.

Instead of going to detectors D and C, the detectors are replaced by half silvered mirrors belonging to two more Mach-Zehnder Interferometer apparatus. These having detectors D and C. They can be called D and C but with prefix U and L (Upper and lower). If preferred or due to necessary constraints just a second interferometer could be used for this part of the investigation. Though two provides more results.

Precision is important in setting up the interferometers.

### Apparatus for primary investigation

Looking for outcome 1, 2, or 3  
outcome at UD and LD, and outcome at  
UC and LC should be the same



## Results:

### Possible outcomes and what they imply

Outcome 1: no detection. May indicate that even a cut photon body is not an indivisible fundamental particle. As will occur if *divisible* into all non detectable members. Supports the photon partition hypothesis for explanation of so called quantum effects. (Check the apparatus is working and set up correctly by testing with opaque blocks removed and getting usual photon detection results.)

Outcome 2: Usual photon behaviour. Detectable as particle or showing interference pattern if paths are reunited.

Supplementary question: If this is found How many times can an un-reunited photon be ‘re-cut’? If the answer is many or indefinitely many it may be indicating that the photon particle partition hypothesis is wrong.

Supplementary experiment: If outcome 2 is found, use a series of interferometers as a modification of the apparatus to investigate; after how many half silvered mirror encounters, the interference pattern ceases to be formed after necessary pathway joining.

Outcome 3: A photon can be detected but no interference pattern can be obtained, suggests that the photon minus its sub photon member can not be re-divided into a cut photon body and sub photon member. Showing that a cut photon body is different from an entire photon. Supports the photon partition hypothesis for explanation of so called quantum effects.

Unexpected: (If UC/ UD results are significantly different from LD/ LC results they may be showing unequal distribution of the kinds of partitioned photon at the half silvered mirror. Which is unexpected. (Symmetric splitting, a 50% each path split, for each kind of divided photon is expected.) Investigate further if found.

## Conclusion:

Hopefully, as this experiment does not require expensive, specialized apparatus, and is quite simple, many institutions will carry it out. Thereby widespread consensus on the nature of a photon can be achieved.

Whatever the outcome of the experiment, useful knowledge will be gained. Either more will be known about photon nature, or evidence in favour of its hitherto assumed fundamental nature will be shown. It is hoped that this experiment becomes a standard demonstration of the nature of photons.

## Acknowledgments

Wikipedia Elitzur–Vaidman bomb tester, via [https://en.wikipedia.org/wiki/Elitzur-Vaidman\\_bomb\\_tester](https://en.wikipedia.org/wiki/Elitzur-Vaidman_bomb_tester), last retrieved 3<sup>rd</sup> March 2022

YouTube video “Why is quantum mechanics weird? The bomb experiment” Sabine Hossenfelder, uploaded 29<sup>th</sup> Aug. 2021

YouTube video “Elitzur-Vaidman bombs”, [MIT OpenCourseWare](https://ocw.mit.edu/courses/8.03sc-physics-of-light-and-optics/), Instructor; Barton Zwiebach, uploaded 6<sup>th</sup> July 2017

March 2000 by David M. Harrison, Department of Physics, University of Toronto via [faraday.physics.utoronto.ca/PVB/Harrison/Locality/Locality.html](http://faraday.physics.utoronto.ca/PVB/Harrison/Locality/Locality.html)

On interaction free testing and photon divisibility, <https://vixra.org/abs/2203.0020>, Woodward, G., 3/3 2020