THE PHILOSOPHY OF SUPERDETERMINISM: BOMBS AWAY ON CAUSALITY!

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The philosophy of superdeterminism is based on a single scientific fact about the universe, namely that cause and effect in physics are not real. In 2020, accomplished Swedish theoretical physicist, Dr. Johan Hansson published a physics proof using Albert Einstein's Theory of Special Relativity that our universe is superdeterministic meaning a predetermined static block universe without cause and effect in physics. The scientifically verified bomb tester experiment also confirms the absence of cause and effect in physics. In this experiment, a photon is directed towards a photon detecting "bomb" that will explode if it comes into contact with the photon preventing the photon from being detected at a later point. Remarkably, the experiment allows for determining whether a bomb is functional or not without detonating it. This is achieved by placing the bomb in one of the paths of a Mach-Zehnder interferometer. If a bomb is live, its mere presence without detonation alters the photon's quantum superposition, changing the interference pattern observed. This experiment demonstrates that a "probabilistic cause" can have a real effect on whether a photon is detected later on despite possibilities not being real by definition. In other words, the bomb tester experiment proves a real effect without any interaction with a real cause confirming that cause and effect are merely illusory appearances of underlying correlations.

The philosophy of superdeterminism is based on a single scientific fact about the universe, namely that we live in a predetermined static block[1] universe without cause and effect in physics.[2] In 2020, accomplished Swedish theoretical physicist, Dr. Johan Hansson proved this fact by applying Einstein's Theory of Special Relativity to what has already been scientifically verified about spin measurement correlations observed in entangled particle pairs. However, the experimentally confirmed "bomb tester"[3] also implies that cause and effect in physics are not real.[4]

The Elitzur-Vaidman bomb tester utilizes a single photon source to emit photons individually. These photons encounter a first beam splitter, a special mirror that creates a quantum superposition, effectively sending the photon along two paths simultaneously.[5] One of these paths leads to the location where the bomb[6] might be placed, while the other path bypasses

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[1] Imagine a cosmic four-dimensional block, where the three familiar dimensions of space (length, width, and height) are combined with a fourth dimension of time. Every single moment in history would occupy a specific location within this block. From this perspective, there is no special "now" moment that separates the past from the future. They all exist equally.

[2] Hansson, Johan. "Bell's theorem and its tests: Proof that nature is superdeterministic – Not random." *Physics Essays* Vol. 33, No. 2 (2020). Dr. Johan Hansson, a professor at Luleå University of Technology in Sweden, has been awarded the "Honorable Mention Award" by the Gravity Research Foundation, a prestigious foundation aimed at advancing the understanding of gravity in fundamental physics. This recognition places him among a group of previous winners that includes Nobel laureates and world-renowned physicists. www.ltu.se/en/latest-news/news/news/2023-05-23-awarded-prestigious-prize-in-gravitational-research#:~:text=Johan%20Hansson%2C%20a%20professor%20at,of%20gravity%20in%20fundamental%20physics.

[3] Elitzur(a), A. and Vaidman, L. "Quantum Mechanical Interaction-Free Measurements." Foundations of Physics 23(7) 987-997 (1993).

[4] Kwait et al. "Interaction-Free Measurement." Phys. Rev. Lett. 74(24), 4763 –4766 (1995).

[5] A photon is a fundamental particle that cannot be split. The beam splitter does not split the photon, but rather splits the possible pathways of the photon.

[6] In the Elitzur-Vaidman thought experiment, the "bomb" is a highly sensitive device designed to explode if it detects even a single photon. It's not literally a bomb in the everyday sense, but rather a conceptual tool to illustrate the principles of quantum mechanics. The key characteristic of this "bomb" is its extreme sensitivity to photons: any interaction with a photon triggers an irreversible change (the explosion). This sensitivity is what makes it a challenge to determine if

the bomb entirely. Each path then encounters a standard mirror that redirects the photon towards a second beam splitter. This second beam splitter recombines the two paths, allowing the photon waves to interfere. Finally, two photon detectors are positioned after the second beam splitter to register the arrival of the photon. The presence or absence of a live bomb along one of the paths, even if the photon does not directly interact with it, influences the interference pattern at the second beam splitter, affecting the probabilities of the photon being detected at each detector.

When no bomb is present, the interferometer[7] is tuned such that constructive interference directs all photons to detector D1, while destructive interference prevents any photons from reaching detector D2. However, the introduction of the bomb, even if the photon does not directly interact with it, modifies this interference pattern. There is now a 50% chance the photon will interact with the bomb and cause it to explode. In the 50% of cases where the photon does not interact with the bomb, the altered interference pattern results in a 50% probability (25% overall) of the photon being detected at detector D1 and a 50% probability (25% overall) of it being detected at detector D2. Therefore, the presence of the bomb shifts the probabilities,

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the "bomb" is functional (a "live bomb") without setting it off. So, the "bomb" is essentially a single-photon detector that explodes upon detection.

[7] In the context of the bomb experiment, the setup, i.e. the arrangement of the photon source, beam splitters, mirrors, and detectors—is the interferometer (specifically, a Mach-Zehnder interferometer). An interferometer is a sophisticated instrument that leverages the wave nature of light (or other types of waves) to make extremely precise measurements. It works by splitting a beam of light into two or more distinct paths, which may differ in length or pass through different media. These separate beams are then recombined, resulting in an interference pattern—a series of light and dark areas—created by the interaction of the waves. This interference pattern is highly sensitive to even the slightest variations in the paths the light has taken. Because of this extreme sensitivity, interferometers can detect incredibly small changes in distance, refractive index, surface irregularities, and other physical quantities. Various types of interferometers exist, each designed for specific applications, ranging from the classic Michelson interferometer used to study light itself to the massive LIGO interferometer designed to detect gravitational waves. Interferometers are indispensable tools across a wide range of scientific and technological fields, enabling measurements of unparalleled precision.

making it possible to detect photons at D2, which would be impossible without the bomb, demonstrating an interaction-free measurement.

The Elitzur-Vaidman bomb tester demonstrates interaction-free measurement because it allows us to infer the presence of a live bomb without the photon ever directly interacting with it. The interferometer is configured such that, in the absence of a bomb, destructive interference prevents any photons from reaching detector D2. However, the mere presence of a live bomb, even if the photon travels down the path that does not contain the bomb, alters the interference pattern. This alteration introduces a probability that the photon will now be detected at D2. Crucially, if a photon is detected at D2, we can definitively conclude that the bomb is present and live. Simultaneously, the fact that the photon reached D2 confirms that it could not have interacted with the bomb, as that interaction would have resulted in the bomb exploding and no photon reaching any detector. Thus, the detection of a photon at D2 provides information about the bomb's presence without any direct interaction between the photon and the bomb itself, hence the term "interaction-free."

The quantum weirdness of photons being detected at D2 in the Elitzur-Vaidman bomb experiment lies in the fact that it reveals the presence of the bomb without the photon ever directly interacting with it. The interferometer is designed such that, in the absence of the bomb, destructive interference completely cancels out any possibility of a photon reaching D2. Therefore, the detection of a photon at D2 is, in classical terms, impossible unless the photon has somehow "known" about the bomb's presence. However, the photon's journey to D2 confirms that it could not have interacted with the bomb, as such an interaction would have triggered the bomb's explosion and prevented the photon from reaching any detector. This implies that the mere possibility of the photon interacting with the bomb, encoded in its quantum superposition, is enough to alter the interference pattern and allow it to reach D2. Indeed, the real effect of the photon being detected at D2 is the result of a cause that did not occur, namely the photon interacting with the bomb. But, the photon detected at D2 never interacted with the bomb and so could not have been transformed by that cause into an effect.

The transformation of the cause into the effect is a crucial aspect of our understanding of causality. But, in the bomb tester experiment a real effect does not have a real cause. Rather, a real effect appears to be the result of a probabilistic cause in quantum superposition without direct interaction with that effect. However, probabilistic causes are better described as correlations rather than causes. When we talk about "probabilistic causes," we are often dealing with situations where a factor increases the likelihood of an outcome, but does not guarantee it. This is where the idea of correlation becomes more relevant. Correlation acknowledges this uncertainty. It says "these things tend to happen together," without necessarily claiming a direct causal link. While we often use the language of "probabilistic causes," it is more accurate to think of these as strong correlations. Correlation is a less committal statement that acknowledges the inherent uncertainty in probabilistic relationships.

The bomb tester experiment demonstrates that nature at its fundamental quantum level does not contain causation, but rather correlations. The detection of a photon at D2 is linked to the potential presence of the bomb. But it is not a direct causal link like "the bomb caused the photon to go to D2." If the bomb directly caused the photon to do anything, it would have exploded. There is a correlation between the presence of the bomb and the increased probability of detecting a photon at D2. A correlation simply means that two things tend to occur together. The bomb's presence correlates with the photon being detected at D2, but the bomb cannot directly cause the photon detection at D2.

Quantum mechanics suggests that everything in the universe, from the smallest subatomic particles to the largest stars, has an associated wave function. Everything that purportedly interacts with some else does so through its wave function. If wave functions use correlations and everything has a wave function, then the interplay of wave functions must be correlations. Moreover, the photon detection at D2 and the photon detection bomb are macro realities existing at our size scale.

Possibility is not reality by definition, because possibility refers to the realm of what could be*,* as opposed to what is real. Therefore, a "probabilistic cause" is not a real cause. Rather, a "probabilistic cause" is merely an expression of the correlation between real states, such as the real state that a photon was detected in D2 and a photon detecting bomb lies in one of the paths of the Mach-Zehnder interferometer. Correlation is not causation. Cause and effect are merely illusions of a physical reality that exhibits strong correlations consistent with quantum mechanics.