THE PHILOSOPHY OF SUPERDETERMINISM AND THE PRINCIPLE OF 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. Some argue that Special Relativity is premised on the principle of causality, and therefore, Dr. Hansson's use of Special Relativity in his proof contradicts his conclusion that cause and effect in physics are not real. However, Special Relativity is not premised on the principle of causality, but rather is consistent with the absence of cause and effect in physics.

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

[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.

in physics.[2] However, the absence of cause and effect in physics[3] directly challenges a fundamental aspect of the principle of causality[4] namely that the cause always precedes the effect. Due to the fact that events do not appear random or arbitrary, we infer that intelligible order is maintained by the reality of cause and effect in physics. However, cause and effect in physics is merely an unproven interpretation of the perceived order of the universe, which can alternatively be explained by the ordering exhibited by our static block universe without cause and effect in physics.

If the principle of causality were real, then every effect would require a cause. If every effect requires a cause, then an infinite series of causes regressing into the past should have occurred. But, such an infinite past would mean that our universe would have long ago entered a

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[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] Dr. Hansson wrote that "[e]verything is predetermined, including the experimenters (non) free will, the 'random' orientation of the spin-analyzers at either end, and anything else you can think of. Each measurement does not create but merely uncovers what already is embedded in space-time. All events leading up to, and including, the 'act of measurement' itself are already there. . . . Bell's theorem and its many experimental tests thus are proof that nature at its fundamental level is superdeterministic – not random. A 'cause' cannot alter the 'effect.' The events in global space-time are predetermined and fixed, much like pebbles cast into a concrete block. . . . What an experimenter seemingly 'chooses' to do at either end A or B is the only thing she can do, and cannot 'cause' either the event at her own position or the event at the other end. All events in the global space-time 'block' we call the universe (past, present and future), observed or not, are superdetermined and unalterable." Hansson, Johan. "Bell's theorem and its tests: Proof that nature is superdeterministic – Not random." *Physics Essays* Vol. 33, No. 2, at 217 (2020).

[4] The principle of causality states that every effect has a cause.

state of high entropy under the Second Law of Thermodynamics.[5] In other words, if cause and effect in physics were real, then you would not be here at this time. The human body is a low entropic state, because the human body is a highly organized system with a complex structure and intricate biochemical processes. Indeed, the fact that you are reading this paper is compelling evidence that cause and effect in physics cannot be real.

In 2020, accomplished Swedish theoretical physicist, Dr. Johan Hansson proved by applying Albert Einstein's Theory of Special Relativity to what has already been scientifically verified about spin measurement correlations observed in entangled particle pairs[6] that cause and effect[7] in physics[8] are not real. Dr. Hansson demonstrated that the opposite spin measurements observed in entangled particle pairs cannot occur unless cause and effect in physics are not real.

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[5] The Second Law of Thermodynamics states that the total entropy of an isolated system always increases over time. So, this law of physics means that the universe tends towards disorder over time.

[6] Dr. Hansson's version of superdeterminism proves the we live in a predetermined static block universe without cause and effect in physics. The other version of superdeterminism posits hidden causal variables responsible for the correlations observed in quantum entangled particles, and thus relies on cause and effect in physics. Indeed, Dr. Hansson's version of superdeterminism disproves any competing version of superdeterminism that relies on cause and effect in physics to posit hidden causal variables.

[7] Dr. Hansson wrote that "[e]verything is predetermined, including the experimenters (non) free will, the 'random' orientation of the spin-analyzers at either end, and anything else you can think of. Each measurement does not create but merely uncovers what already is embedded in space-time. All events leading up to, and including, the 'act of measurement' itself are already there. . . . Bell's theorem and its many experimental tests thus are proof that nature at its fundamental level is superdeterministic – not random. A 'cause' cannot alter the 'effect.' The events in global space-time are predetermined and fixed, much like pebbles cast into a concrete block. . . . What an experimenter seemingly 'chooses' to do at either end A or B is the only thing she can do, and cannot 'cause' either the event at her own position or the event at the other end. All events in the global space-time 'block' we call the universe (past, present and future), observed or not, are superdetermined and unalterable." Hansson, Johan. "Bell's theorem and its tests: Proof that nature is superdeterministic – Not random." *Physics Essays* Vol. 33, No. 2, at 217 (2020).

[8] Physics is the fundamental science that studies matter, energy, motion, and force. Physics explores everything from the incredibly small (subatomic particles) to the unimaginably vast (the cosmos).

Experiments have shown that when the spin of the first entangled particle is measured, then the spin of the second entangled particle will always be the exact opposite spin regardless of how far apart you place the particles when measured.[9] However, the spin of the first entangled particle measured for spin-1/2 particles, like electrons, will always be a purely random 50-50 result between Up or Down spin. This raises an inconsistency with Einstein's Special Relativity when observed from different inertial frames of reference.[10]

Observers in different frames of reference can observe a different entangled particle measured first due to the relativity of simultaneity.[11] As a result, two different observers each observing a different entangled particle measured first can observe conflicting spin measurement results for the pair. If Observer 1 sees particle A measured first with an Up spin, then particle B must show a Down spin for Observer 1. But, if Observer 2 sees particle B measured first with an Up spin, then particle A must show a Down spin for Observer 2. Observers 1 and 2 would see

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[9] Aspect, A. et al. "Experimental Realization of Einstein-Podolsky-Rosen-Bohm *Gedankenexperiment*: A New Violation of Bell's Inequalities" *Physical Review Letters* Vol. 49, No. 2 (1982).

[10] An inertial frame of reference is a frame of reference in which an object at rest remains at rest and an object in motion moves in a straight line at a constant speed unless acted upon by an external force. Essentially, it is a reference point that is not accelerating. Think of it like a smoothly moving train: if you're inside and not near the windows, you can't tell if the train is moving at a constant speed or stationary. This is because the train is an inertial frame of reference.

[11] The relativity of simultaneity in Einstein's Theory of Special Relativity means that two events that occur at the same time for one observer may not occur at the same time for another observer who is moving relative to the first. This idea challenges our intuitive understanding of time. In our everyday lives, we tend to think of time as absolute, flowing uniformly for everyone, regardless of their motion. However, special relativity tells us this is not the case. This happens because the speed of light is constant being the same for all observers regardless of their motion. To visualize this, imagine two lightning strikes hitting opposite ends of a moving train simultaneously from the perspective of someone standing on the platform. To someone on the train, the lightning strikes might appear to happen at different times due to their motion relative to the platform. This concept might seem counterintuitive, but it is a cornerstone of modern physics and has been experimentally verified.

inconsistent spin measurement results for the pair of entangled particles. This potential conflict in spin measurement results occurs because of the random 50-50 chance of observing either an Up or Down spin on the first particle observed to be measured.

The only way to explain how the spin measurement results can be consistent for all observers regardless of inertial frames of reference is to say that the spin measurement results must be predetermined for all observers.[12] If Observer 1 is predetermined to see particle A measured with an Up spin, and Observer 2 is predetermined to see particle B measured with a Down spin, then the spin measurement results between the two Observers can always match even though the spin measurements still appear to the Observers to be completely random results. This is an example of predetermined randomness[13] and not caused randomness. If the random spin measurements were actually caused when the first entangled particle observed was measured, then there would be an inconsistency in spin measurement results which would violate the principle that there is no preferential frame of reference in Special Relativity or quantum mechanics. Consequently, Dr. Hansson proved that actual cause and effect in physics cannot be real using Einstein's Theory of Special Relativity, because eliminating cause and effect in physics is the only way to explain how the spin measurement results can be consistent when viewed from any inertial frame of reference.

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[12] Dr. Hansson concludes that "[t]here is no other possibility than that the outcomes at A and B both are predetermined." Hansson, Johan. "Bell's theorem and its tests: Proof that nature is superdeterministic – Not random." *Physics Essays* Vol. 33, No. 2, at 217 (2020).

[13] The idea of "predetermined randomness" simply means an initial encounter with pre-existing pure randomness. So, in our static block universe where all purely random events exist equally whether in the past, present or future, one can encounter pre-existing purely random events for the first time as one enters future portions of the static dimension of time.

However, some critics argue that Dr. Hansson's use of Special Relativity in his proof contradicts his conclusion that cause and effect in physics are not real. Critics argue that Special Relativity is premised on a fundamental aspect of the principle of causality namely that the cause always precedes the effect. There are two postulates that led to the development of Special Relativity. Firstly, the principle of relativity says that the laws of physics are the same in all inertial frames of reference. Secondly, the principle of the constancy of the speed of light says that the speed of light in a vacuum is the same for all observers regardless of the motion of the light source or observer. The purported explanation for why the speed of light is the same for all observers is the principle of causality. Because exceeding the speed of light would require backwards time travel,[14] then the speed of light limitation is believed necessary to avoid the causal paradoxes backwards time travel might cause. In other words, because cause must always precede effect, then one cannot exceed the speed of light resulting in backwards time travel, because that would allow an effect to precede its cause. For example, traveling back in time would allow you to prevent the cause of your own existence.

However, the absence of cause and effect in physics also prevents backwards time travel. Backwards time travel is impossible, because one could not actually cause a change to a predetermined future by going backwards in time in the absence of cause and effect in physics. For example, one could not travel backwards in time in order to prevent one's parents from meeting, because one could not actually cause a change to the predetermined future that one's

[14] Time dilation, in the context of special relativity, refers to the phenomenon where time appears to pass slower for an object that is moving at a significant speed relative to an observer. For example, a clock on the moving object would tick slower than a stationary clock as observed by the stationary observer. Essentially, time is dilated or stretched out for the moving object. As one travels closer and closer to the speed of light, time passes slower and slower toward a limit of time stopping at the speed of light. Theoretically, if one could travel faster than the speed of light, then time would move backwards.

parents would meet and later produce you. Indeed, present events cannot actually cause future events in the absence of cause and effect in physics. Consequently, future events must be predetermined and already exist in the dimension of time of our static block universe.

The speed of light limitation is consistent with the absence of cause and effect in physics. Because cause and effect in physics are not real, then backwards time travel is not possible due to the impossibility of actually causing a change to predetermined future events. Moreover, Dr. Hansson's proof presents a thought experiment under Special Relativity in which "'cause' and 'effect' have become scrambled and ill-defined."[15] The cause of the correlated spin measurements for Observer 1 is also the effect for Observer 2. This apparent role reversal of cause and effect does not lead to any causal paradox, because both Observers see the same correlated spin measurement results. Dr. Hansson's proof demonstrates that causal paradox is not an issue in Special Relativity and therefore, aversion to causal paradox is not the reason for the speed of light limitation. Consequently, Special Relativity and the constancy of the speed of light for all observers is not premised on the principle of causality, but rather are consistent with Dr. Hansson's proof that cause and effect in physics are not real.

[15] Hansson, Johan. "Bell's theorem and its tests: Proof that nature is superdeterministic – Not random." *Physics Essays* Vol. 33, No. 2, at 217 (2020).