

Reality doesn't exist

<https://youtu.be/2XnKrVhZQ-k?si=OhT9b0vbqtkJ2-3K>

Forward

A transcript from the YouTube video; — Lisa Randall Truth

Parenthetical and italicized text are mine.

I submit the following for your consideration in your modern understanding of the knowledge that Shakyamuni Buddha was trying to convey some almost 3000 years ago to a largely illiterate people as well as all caste up to the intellectual (*Brahman*) caste of India.

My constant goal is to make the history and scholarship of Buddhism and its founder's teachings as easy to understand as this modern era of Mappo can transmit. With the access to our great scholars in both Buddhist lineage as well as those academically trained, this wealth of information can be overwhelming. It is my task to reduce the noise or extraneous pursuits of politicized agendas to deliver a paired back but no simplified, straightforward teaching without distraction. The sciences today, from physics and cosmology to psychology and neurology, provide a glut of observable truths that apply directly to our Buddhist practices and rhetoric. I provide here a direct transcription of video talks from the Internet with interruptions of personal insight regarding Buddhist teachings and practice, as a guide to interrelate our practice with the provided text.

Si fu, Bodhisattva Sylvain Chamberlain

Love and respect,

NaMuMyoHoRenGeKyo

Transcript Annotated

Scientists ran an experiment in 1982 to prove that reality exists when nobody is looking at it. They were wrong. Not slightly wrong. Not wrong in a way that needed a small correction. Wrong in a way that meant everything, every object, every wall, every atom in your body might not actually exist in any definite state until something or someone forces it to.

The experiment was called the Aspect experiment. It was run by **Alain Jean Aspect** at the *Institute de Physic* in Paris. It was designed to settle once and for all the most dangerous question in the history of physics. And what it proved, what the data showed, clear and undeniable, was the thing that physicists had spent 50 years desperately hoping was not true.

Before we go any further, I want to be precise about what I mean because this is not philosophy and it is not metaphor.

In 1935, **Albert Einstein, Boris Podolski, and Nathan Rosen** published a paper in the journal *Physical Review*. The paper was called, "*Can quantum mechanical description of physical reality be considered complete?*" It became known as the **EPR** paper. And in it, Einstein argued that quantum mechanics, the branch of physics that describes how particles behave at the subatomic level, could not be the final word on reality. It had to be incomplete.

Because if it were complete, if quantum mechanics was actually literally true, then something deeply fundamentally horrifyingly impossible would have to be happening. Einstein gave that impossible thing a name. He called it *spooky action at a distance* and he said with the full weight of his authority as the most celebrated physicist alive that it could not be real. He was wrong.

In 2022 the *Nobel Prize in physics* was awarded to **Alain Aspect, John Clauser and Anton Zylinger** specifically for proving that Einstein was wrong. Specifically for proving that spooky action at a distance is real. Specifically for proving that the impossible thing is happening. Stay with me because the implications of what they proved are not just strange. They are world ending.

In the next 50 minutes, you are going to understand three things.

1. The first thing is what the Aspect experiment actually did. Not the version you get in a pop science article, but the real version, the one that involves detector angles and correlation statistics and a loophole called local hidden variables that took 30 years to close. You are going to understand it well enough that when someone tells you quantum mechanics is weird, you will be able to tell them precisely how weird and what that weirdness means.
2. The second thing you are going to understand is why the result of that experiment is not just a curiosity about tiny particles in a laboratory. It is a statement about the nature of reality at every scale including the scale of the chair you are sitting on, the room you are in, and the neurons firing in your brain right now as you process these words.
3. The third thing, and this is the one I want you to hold on to, the one that people come back to this video for, is what this experiment implies about you, about the observer, about whether the thing doing the observing is itself part of the system it's observing, about whether consciousness, your consciousness, the thing you call your inner life, the experience of being you, whether that has a role in the structure of physical reality that physics has not yet figured out how to account for. That question does not have a clean answer. If it did, the physicists who proved this result would not still be arguing about it in the pages of peer-reviewed journals 40 years later.

Stay with me because the last part changes everything. I want you to do something for me right now. Look at your hand. Not metaphorically. Actually, look at it. Hold it up in front of your face if you need to. Look at the skin, the lines, the small ridges of your fingerprints. Look at the way the light catches the surface. Look at the way it is

solid, bounded, present, unambiguously there. And I want you to think about what that hand is made of. It is made of cells. The cells are made of molecules. The molecules are made of atoms. Each atom is mostly empty space. A nucleus surrounded by electrons with a distance between them that if you scaled a nucleus up to the size of a marble would put the nearest electron about a mile away. Your hand is almost entirely empty space. The part that is not empty space, the nucleus, the electrons, those are themselves not solid objects in any meaningful sense. They are probability distributions. They are clouds of likelihood. They are, according to the mathematics that has been tested to greater precision than any other theory in the history of science, not in any definite place until something interacts with them and forces a definite *momentary* state.

Your solid hand, your unambiguously fair hand, is made of things that do not have definite positions. Now, here is the question the Aspect experiment was designed to answer. If two of those particles, two electrons, two photons, any two quantum objects, if two of those particles interact with each other under the right conditions, they can become what physicists call entangled. Entanglement means that the two particles share a quantum state, they are described mathematically, not as two separate things, but as one system. And when you measure one of them, when you interact with it in a way that forces it into a definite state, the other one instantly, regardless of how far away it is, also snaps into a definite state, not a moment later, not after a signal travels between them. Instantly.

(See the transcription on “Quantum Tathagata”, where the discussion is about all “distance” in this cosmos is zero. Distance, it would appear, is a property of experience rather than a physical “reality”)

Einstein said this was impossible because if it were true, it would mean that information or at least some kind of influence was traveling faster than light. Nothing travels faster than light. That is not a guideline. That is the law that holds the structure of space and time together. Violate it and you violate causality itself. You allow effects to precede causes. You allow the future to influence the past. You allow the entire logical architecture of the universe to collapse.

So Einstein said there must be a hidden explanation. There must be some property of the particles, some variable we cannot see yet, some fact about each particle that was set at the moment they separated that determines how each one will behave when measured. The particles are not really connected. They just carry instructions we cannot read. He called these hidden variables. And that is the theory that Alan Aspect in a laboratory in Paris in 1982 set out to destroy. To understand what Aspect did, you first need to understand what John Bell did 17 years earlier. Because without Bell, there would have been no Aspect experiment. Without Bell, the argument between Einstein and the quantum physicists would have remained forever a philosophical dispute. Interesting, irresolvable, ultimately untestable.

Bell is the person who turned a metaphysical argument into a scientific one. He is the person who gave us a way to actually check. **John Stewart Bell** was an Irish physicist working at **CERN** in the 1960s. He was by his own account deeply uncomfortable with quantum mechanics. Not because he did not understand it. He understood it better than almost anyone, but because he understood it too well. He

could see in the mathematics exactly what quantum mechanics was claiming about reality and it disturbed him. It disturbed him the way a building disturbs you when you can see that the load bearing walls are not where they should be. In 1964, Bell published a paper in the journal physics. It was called on the Einstein, Podolski, Rosen paradox. In that paper, Bell did something extraordinary. He proved mathematically that if Einstein was right, if hidden variables existed, if particles carried preset instructions that determined their behavior, then the correlations between measurements of entangled particles could only reach a certain level. He derived an inequality, a mathematical limit. If you ran an experiment, measured pairs of entangled particles, and calculated the statistical correlation between their results, then that correlation under Einstein's hidden variable theory could not exceed a certain value. That value is now called Bell's inequality. Bell then showed that quantum mechanics, the equations, the actual predictions of the theory, predicted correlations that violated his inequality, that went above the limit, that exceeded what hidden variables could possibly produce. This was the weapon. This was the test. Run the experiment. Measure the correlations. If they stay within Bell's limit, Einstein was right. Hidden variables exist and quantum mechanics is incomplete. If they exceed Bell's limit, if they violate Bell's inequality, then Einstein was wrong. Hidden variables do not exist, and quantum mechanics is telling us something about reality that we do not have good words for yet. Bell published his paper, and for more than a decade, nobody ran the experiment. Not because it was unimportant. Everyone who read it understood that it was perhaps the most important paper in the foundations of physics since Einstein.

But because the technology did not quite exist yet because the experiment required producing pairs of entangled particles reliably measuring them quickly enough and closing enough loopholes to make the result airtight. It required in short Alan Aspect. Aspect was a graduate student at the institute in Paris when he first read Bell's paper. He later said that reading it was like being hit by something physical. He immediately understood what was at stake. He dedicated the next decade of his scientific life to running the test.

The experiment he designed worked like this: A calcium atom is excited by a laser until it emits two photons simultaneously. A photon is a particle (*quanta*) of light. When two photons are emitted together from a single calcium atom in this way, they are entangled. They share a quantum state. Specifically, a property called polarization.

Polarization describes the orientation in which a photon oscillates. In ordinary light, photons are polarized in all different directions. In aspects experiment, each pair of photons is produced in a superposition of polarization states. Meaning before measurement, neither photon has a definite polarization to exist in all possible polarization states simultaneously. Not as a metaphor, as a mathematical and physical fact. The two photons are sent in opposite directions toward two detectors placed some distance apart. Each detector has a polarization filter, a device that measures whether the arriving photon is polarized in a particular direction. The filter can be set to different angles.

When a photon arrives at a detector, the detector records a result. Either the photon passes through the filter or it does not. A one or a zero, a yes or a no.

Now, here is where Bell's inequality becomes concrete. If you measure both photons with filters set at the same angle, you find that they always give the same result. Always. If one passes through, the other passes through. If one is blocked, the other is blocked. This is not surprising. This is consistent with hidden variables. You can explain it by saying the photons were always polarized the same way. They carried the same instruction from the beginning and we are simply reading out the same prewritten answer at both ends. But Bell showed that if you measure the photons with filters set at different angles and if you vary those angles across many measurements and if you calculate the correlations across all those measurements, then the statistical pattern of results can distinguish between hidden variables and genuine quantum entanglement.

Hidden variables produce one pattern. Genuine entanglement produces a different pattern. And the two patterns are distinguishable if you measure precisely enough and run enough trials. Aspect ran hundreds of thousands of trials. The expectation, the result that Einstein's theory, the hidden variable theory, the theory that particles carry preset instructions and are not genuinely connected. The result that theory predicted was simple. The correlations would stay within Belle's limit. The numbers would respect the inequality. Reality would turn out to be local, meaning particles only respond to what is immediately around them. Reality would turn out to be realistic, meaning particles have definite properties whether or not anyone measures them. The world would make sense.

There was a reason to hope for this result beyond mere comfort. The alternative was genuinely disturbing. If the correlations violated Belle's inequality, if Aspect found that the photons were more correlated than hidden variables allowed, then one of two things had to be true. Either the two photons were somehow communicating faster than light, sending some signal between them at the moment of measurement that said what result to give or there were no hidden variables at all. The photons genuinely did not have definite polarization before measurement. The measurement itself, the act of looking was creating the reality it claimed to be observing. Both options are from the perspective of classical physics from the perspective of everything we thought we knew about how a universe works. catastrophic aspects results violated Belle's inequality.

Decisively, unambiguously, not slightly, not in a way that required careful interpretation. The correlations between the photons were stronger than hidden variables could possibly produce. They matched with extraordinary precision the predictions of quantum mechanics. And critically, Aspect's version of the experiment closed the most important loophole that earlier experiments had left open. The loophole was called the locality loophole. It said, "What if the two detectors are somehow communicating with each other? What if there is some signal passing between them that coordinates the results?" To close this loophole, Aspect used detectors that switch their filter angles randomly at a time scale faster than light could travel between them. He made it physically impossible for the detectors to share information before each measurement was made. The results still violated

inequality. There was no communication between the detectors. There was no hidden variable. The photons were genuinely entangled and the act of measuring one of them, the act of forcing it into a definite state was instantaneously determining the state of the other regardless of the distance between them.

Aspect published his results in 1982. The physics community received them with what can only be described as horrified respect. Nobody found an error. Nobody found a loophole that invalidated the conclusion. Over the following four decades, the experiment was repeated hundreds of times by dozens of independent groups with increasingly sophisticated technology and increasingly airtight controls. In 2015, a team at Delft University of Technology in the Netherlands ran what is now called the loophole-free bell test, an experiment that simultaneously closed every known loophole. The results were the same.

Bell's inequality was violated. Quantum entanglement is real. In 2022, the Nobel Committee awarded its highest prize in physics to the people who proved it. Now I want to tell you what this means, not what the popular science version says it means, what the physics actually says it means. When Aspect's photon reaches a detector and the detector measures its polarization, the photon snaps from a superposition of all possible polarization states into a single definite state. This is called the collapse of the wave function. The wave function is the mathematical object that describes all possible states the particle could be in before measurement. It contains all possibilities simultaneously. After measurement, it contains one. The collapse is instantaneous. It is not caused by anything we can point to in the physics.

(It seems obvious to me today, that what is referred to as "the wave function" is just another way of saying "potential" or "Potential probability".)

It just happens when measurement occurs. And simultaneously, and this is the part that breaks things, the other photon, the entangled partner, regardless of whether it is 1 meter away or 1 billion light-year away, also collapses into the correlated state instantly. Not after any signal has had time to travel. Instantly. What does this mean? It means that before a measurement, neither photon has a definite polarization. They are genuinely indefinite. Reality at the quantum level is not a fixed landscape that we walk through and observe. It is a landscape that does not fully exist until it is observed. The observation is not a passive act of reading off a pre-existing value. The observation is the event that brings the value into existence.

(It is at this point that I would reference my slide presentation on Space/Time 2 and Karma", dealing with "time" as an instantaneous momentary experience of the process of formation. It is like our existence occurs in the midst of quantum fluctuation at all moments consecutive only in their instantiations, also included on this resource page.)

This is not a statement about our ignorance. This is not saying the polarization was always there. We just did not know what it was. Bell's inequality rules that out. If the polarization was always there, if the particles carried hidden instructions, the correlations could not be as high as they are. The correlations are only possible if the states are genuinely created at the moment of measurement.

Reality at the quantum level is participatory. Now, you might be thinking this is all about photons, tiny particles. This does not apply to chairs and hands and rooms and people. Quantum effects average out at large scales. The world I live in is a classical world. And you are right that quantum effects average out. The process by which they average out is called decoherence.

Decoherence happens because large objects interact with enormously many particles at once. Air molecules, photons, electromagnetic fields. And all of those interactions effectively perform measurements on the system continuously. The superposition collapses almost instantly before it can be observed as a superposition.

But here is what decoherence does not do. It does not explain why there is one definite outcome rather than another. It does not explain what chooses which branch of the superposition becomes real. It does not tell you why when the detector and aspects experiment clicks, it clicks for one result rather than all results simultaneously. It tells you why the superposition disappears quickly. It does not tell you where the other possibilities go. And physicists have been arguing about this genuinely technically without resolution for nearly a century. The Copenhagen interpretation, the original and still most widely taught interpretation says, "Do not ask. The wave function is a calculational tool. When you measure, you get a result.

The question of what happens to the other possibilities is not a scientific question." The many worlds interpretation proposed by Hugh Everett in 1957 and now taken seriously by a significant fraction of physicists says all results happen. Every time a quantum measurement occurs, the universe branches. Both outcomes exist. You the observer split two. There is a version of you in which the photon passed through the filter. There is a version of you in which it did not. Both are equally real. You only experience one because you are now entangled with the outcome you observed.

The pilot wave interpretation championed by **David Bohm** says the wave function is real. It guides particles along definite trajectories. The randomness is epistemic rather than fundamental. But the wave function is non-local meaning it extends across all space instantaneously. and the way it guides particles is not something that can be explained by any local classical mechanism. And then there is the most radical interpretation of all the one that the **Nobel laureate Eugene Wigner** took seriously. The one that **John Wheeler** spent his later career developing. The one that the physicist **John von Neumann's** mathematical analysis of quantum mechanics seems to lead to almost inevitably. The interpretation that says the collapse of the wave function requires a conscious observer, not a detector, not a measuring device, a mind. von Neumann showed in 1932 in his foundational textbook on quantum mechanics that if you trace the chain of physical causation from the quantum system to the detector to the recording device to the person reading the recording device, you cannot find at any purely physical step the point at which the superposition collapses. **The collapse only resolves the mathematics only closes at the level of subjective experience.** At the point where something becomes aware of a result.

This is called the von Neumann Wigner interpretation. Most physicists reject it or at least find it deeply uncomfortable. But none of them have refuted von Neumann's

mathematics. The chain of reasoning that leads to it is by most accounts formally valid. John Wheeler, one of the giants of 20th century physics, developed this into something he called the participatory universe. Wheeler argued that the universe is not a machine that runs independently of observation. **It is a self-excited circuit.** It calls itself into existence through the act of being observed. He said in a phrase that has become one of the most quoted in all of physics, "**No phenomenon is a real phenomenon until it is an observed phenomenon.**" And then he pushed further.

He asked, "If observation brings quantum states into definite existence, if quantum states underlie all of physical reality, then what was the state of the universe before any observer existed to observe it?"

Even in the present looking backward through time participates in bringing the past into definite existence. This is called the delayed choice experiment. Wheeler proposed it as a thought experiment. It has since been run in the laboratory. The results say what predicted they would say. But we are getting ahead of ourselves.

We have not yet arrived at the deepest implication of what aspect proved. We have not yet asked the question that makes physicists fall silent in conference rooms.

Here is the question. If observation collapses the wave function, if the act of looking brings definite reality into existence, then what is the observer? Every experiment we have ever run, the observer is a physical system. The detector is made of atoms. The photo multiplier tube is made of atoms. The scientist reading the readout is made of atoms. And atoms, as we established at the beginning of this video, are quantum objects. They are probability distributions. They are before being observed not in any definite state. So the observer that collapses the wave function is itself a quantum system and a quantum system before being observed is in a superposition of states.

This is the measurement problem.

This is the thing that sits at the heart of quantum mechanics like a stone that nobody can move. The theory that most precisely and successfully describes physical reality requires an observer to make sense of its predictions.

But observers are themselves part of physical reality and physical reality according to the theory does not have definite states without observers. It is a loop with no beginning. A sentence that references itself, a map that contains itself as territory.

When Schrodinger, the physicist who gave us the wave function, illustrated this loop with a thought experiment that has become the most famous in science. He described a cat sealed in a box with a quantum device, a radioactive atom, and a mechanism that would kill the cat if the atom decayed.

The atom is in a superposition of decayed and not decayed. Before anyone opens the box, the mechanism is in a superposition of triggered and not triggered. And therefore following the mathematics the cat is in a superposition of alive and dead. Schrödinger was not claiming that cats are literally alive and dead simultaneously. He was demonstrating that quantum mechanics applied consistently leads to a conclusion that makes no sense at the macroscopic scale we actually live in. He was showing the crack in the theory. The place where the mathematics and common

sense violently disagree. That crack has never been sealed. What the Aspect experiment proved is that the crack is not a mathematical artifact. It is not a problem with the equations. It is a real feature of the physical world.

Particles do not have definite states before measurement. The correlations prove it. The Nobel Prize confirms it. And if particles do not have definite states before measurement, then the question of what constitutes a measurement, what counts as an observation is not a peripheral philosophical footnote. It is the most important open question in fundamental physics.

And here is where it becomes personal. Here is the line I want you to sit with. If you trace the chain of interactions from a quantum particle to a definite result, if you follow the physics from the subatomic level all the way up, you eventually arrive at the only place in the known universe where definite particular first person experience is confirmed to exist inside a conscious mind. The universe spent 13.8 billion years producing the conditions for that experience to exist. Stars had to live and die to forge the heavy atoms. Planets had to cool to produce the chemistry. Evolution had to run its four billion year algorithm to produce a nervous system complex enough to host awareness. And now in you right now there is something it is like to “be”.

There is a subject. There is a perspective. There is a point from which the universe is experienced as definite, particular, and real. The question that physics has not answered and that the Aspect experiment makes unavoidable is whether that subject that perspective experience of being a specific entity watching a specific world is doing something to the universe. Whether the consciousness that sits at the end of the measurement chain is a passive recipient of a reality that would exist without it or whether it is in some sense that we do not yet have the mathematics for part of what makes reality real. I'm not telling you the answer. There is no answer. Not yet. But I'm telling you that this is not a question philosophers invented.

This is a question that experiments in laser optics and Nobel Prize winning physicists in the most precisely tested theory in the history of science have placed directly in front of us. The data insists we look at it. And the most disturbing thing about what the data shows is not what it tells us about particles. It is what it refuses to tell us about ourselves.

Let me bring you back to where we started. I told you that scientists ran an experiment in 1982 to prove that reality exists when nobody is looking. They ran it. They got the data. The data told them reality does not work that way.

I told you that you were going to understand three things.

The first was the Aspect experiment. You now know what Bell's inequality is and why it matters. You know what entanglement means. Not the pop science version, but the real version. Two particles sharing a quantum state, neither having definite properties until measured; and the measurement of one instantaneously determining the state of the other regardless of distance. You know that this was tested with polarized photons and calcium atoms and randomly switching detectors

and hundreds of thousands of trials. And you know that the result the Nobel Prize winning loophole-free unanimously replicated result is that Bell's inequality is violated. Hidden variables do not exist. Einstein was wrong. The impossible thing is happening.

The second was why this matters beyond the laboratory. You now understand that the quantum world is not a separate sealed domain that only operates at scales too small to affect your life. The quantum world is the foundation of your life. Every atom in your body is governed by the same mechanics that Aspect's photons demonstrated. The classical world you inhabit is not a separate reality. It is a large scale averaging of quantum reality. The coherence averages out the visible weirdness, but it does not eliminate the underlying structure. And the underlying structure says definite reality is not the ground state.

Third, definite reality is the result of interaction, of measurement, of something looking.

(That something is the cosmos, it is the Bulk quiescent energy, it is the Engine of Life, the karma, it is "you", your mind.)