

The Myth of the 'Observer Effect' in Quantum Physics



Why the von Neumann-Wigner interpretation of quantum mechanics is so popular but remains a fringe speculation that almost no physicist supports. [MARCO MASI](#)

You may have heard about the so-called 'observer effect' in quantum physics (QP). It is a particular interpretation of QP, also known as the 'von Neumann-Wigner interpretation,' and that relates to one of those many weird aspects of QP that has sparked so many speculations, conjectures, and controversies. Much too

often I hear people saying that in QP the outcome of an experiment depends on the observer's mind or consciousness. Some go even so far as stating that this supposedly demonstrates how reality comes into existence only because of our observations or, because of a conscious observer.

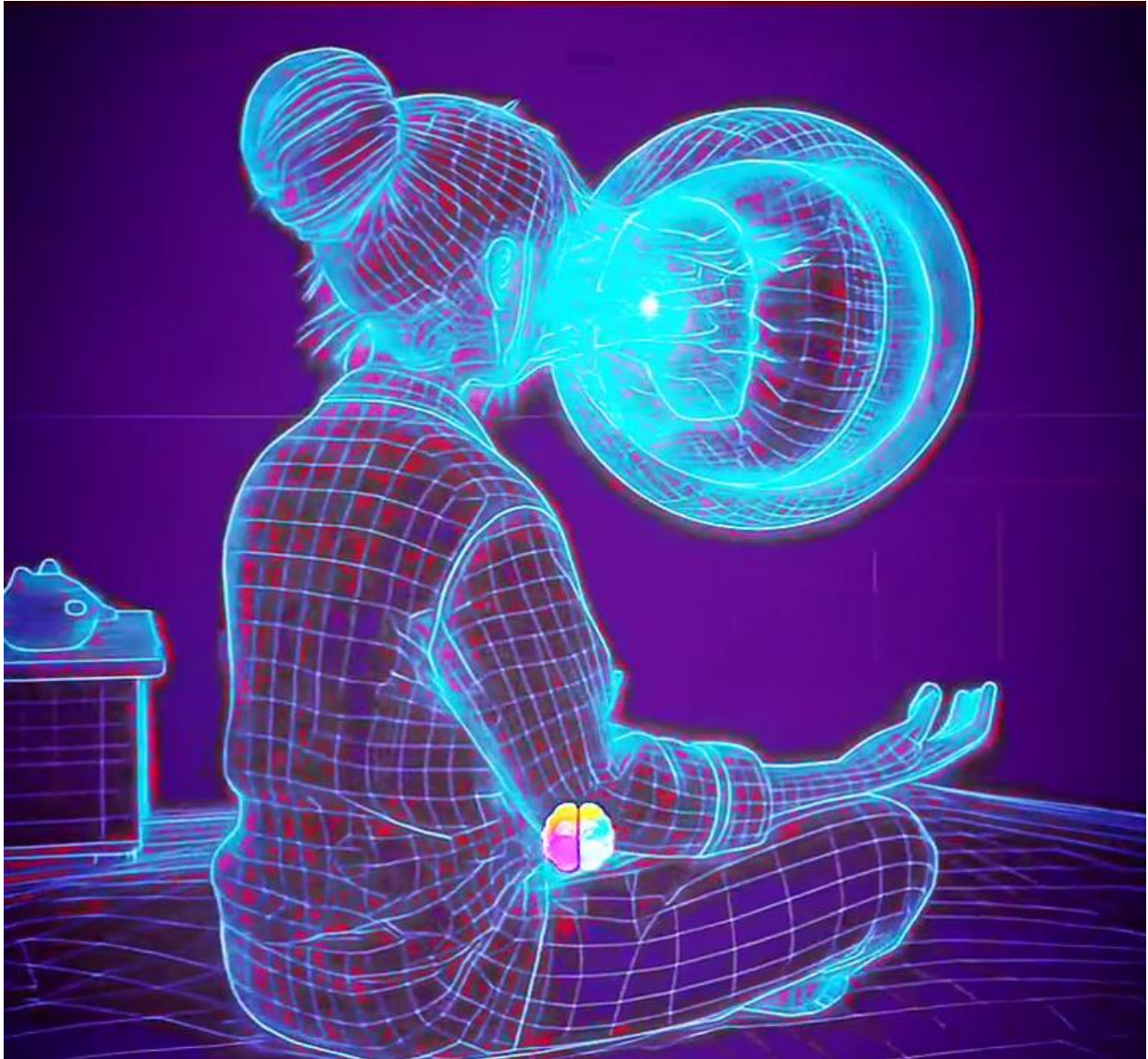


Before Observation - Wave - spread out over space and time



At the time of observation - Particle- localised space time event

First of all, without going too much into the technical details, let us see what the facts are and what this 'observer effect' is really about.



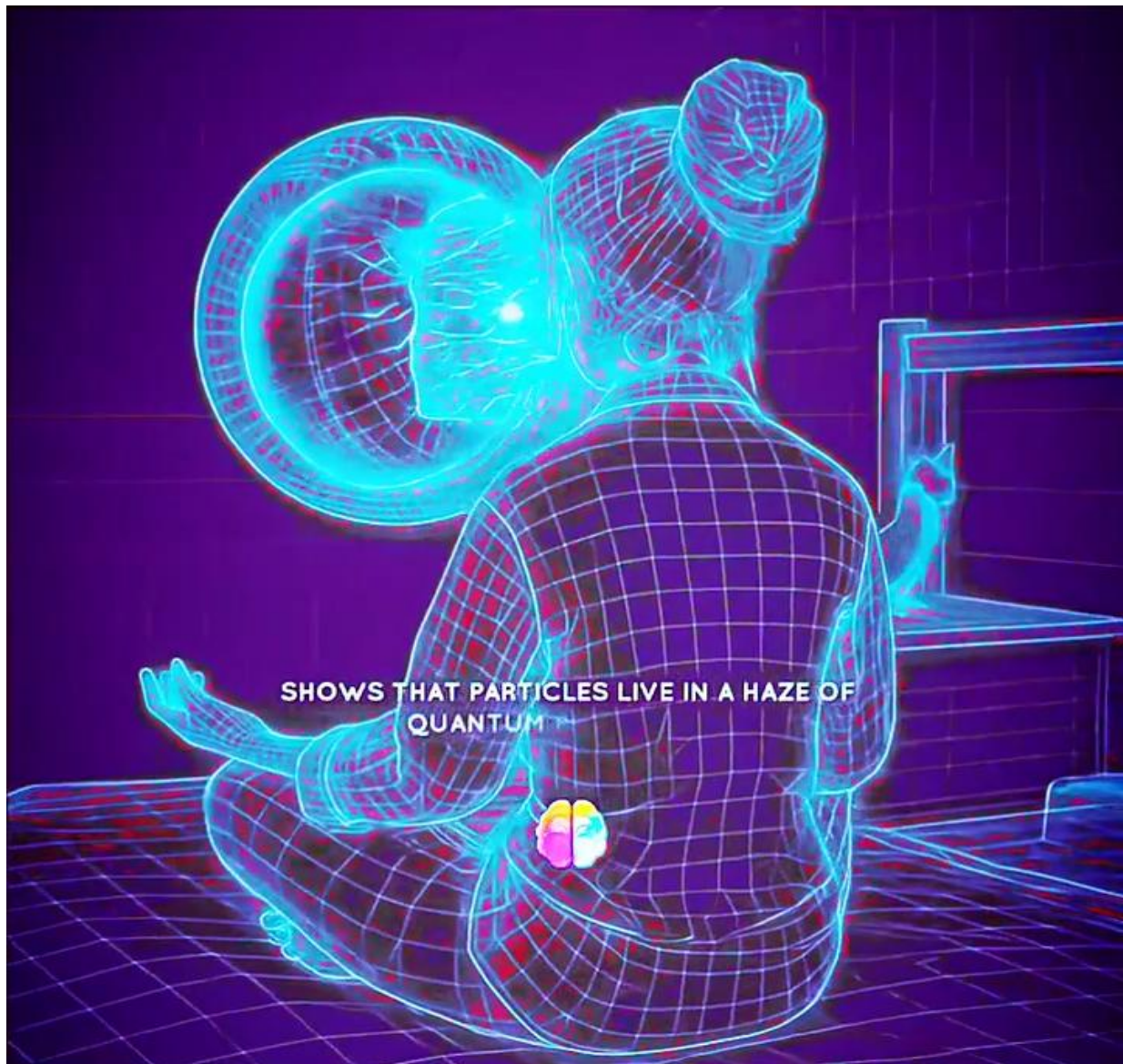
In the microscopic world of QP, things have a strange and unintuitive indeterministic character. For example, according to Heisenberg's uncertainty principle, we can't measure with absolute precision both the position and the momentum (the quantity of motion, just imagine the speed) of a particle. If you try to find out with increasing precision the position of a particle you will see an increase in the uncertainty over its speed, and vice versa. In practice, this translates into the fact that, when someone makes several measurements, the outcome of every measurement—say, for example, of the position of a quantum particle like an electron—

is always a bit indeterminate, uncertain, just fuzzy, even though the overall number of measurements will center around an average expected value. This uncertainty has nothing to do with the imprecision of our measurement devices, it is an inherent uncertainty that will always show up, no matter how precise your measurement will be.



Contrary to some common misleading beliefs, quantum indeterminism isn't caused by the interaction between the measurement device and the particle either. This quantum

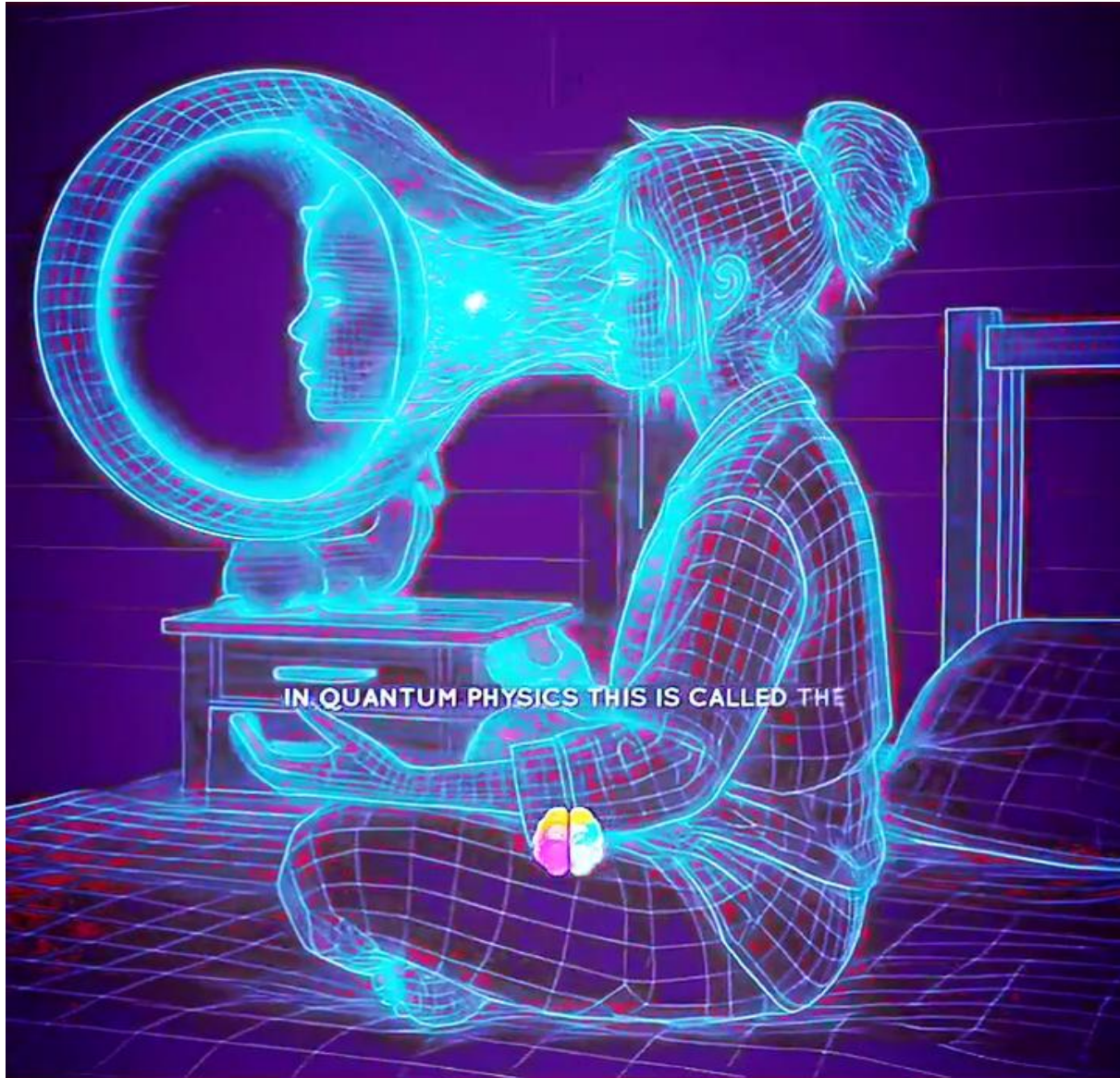
uncertainty is misleadingly interpreted as the uncertainty arising due to the interaction between an observer and the quantum system. Because, as the saying goes, when we interact with microscopic objects by observing them, say with light particles through a microscope, we inevitably perturb the system and modify it. This tiny but inevitable perturbation—that is, the ‘observer effect’—modifies reality only because we observe it and, thus, in a sense, reality is in the eye of the beholder.



This interpretation of the observer effect in quantum physics has become pervasive for a simple historical reason: it was none other than Werner Heisenberg's first interpretation of his own uncertainty principle. He showed that if we try to determine the position of a particle through a microscope, the photons hitting it will inevitably displace it, making it impossible to observe its position with absolute precision. While this is a correct description of the physical process, it turned out to be an overly simplistic understanding of what the uncertainty principle truly means. First, because it can be shown that quantum uncertainty is an inherent property of particles that exists even without interactions, and, more importantly, because this setup with a microscope and a human observer might suggest to some (though not to Heisenberg) that the mind or consciousness of the observer is participating in the process.

First of all, notice that, in physics, with 'observer' one means a measurement device, such as a photodiode, a CCD camera, a photographic plate, etc. The 'observer' needs no consciousness or mind to 'observe'—that is, to perform a measurement.

Secondly, nowadays, using modern electronic and quantum optical devices, one can perform so-called 'interaction-free measurements' which are a very smart way to test quantum effects, such as the uncertainty principle, without interacting with the system at all. Yet, the uncertainty remains ineliminable—there are no hidden causes or 'hidden variables'—showing that quantum uncertainty is fundamental and intrinsic in the quantum nature of things, it is not induced as a result of a noisy observer effect.



In other words, every measurement will be affected by some random fluctuations that are unpredictable, and there is nothing we can do about it. It is not due to a lack of knowledge about the real position of a particle, rather this uncertainty is an inherent aspect of reality, an ontological aspect of QP. First, the quantum particle exists in a state where multiple measurement outcomes are possible. However, at the moment the measurement takes place, it 'collapses' into a single determinate state (the famous 'collapse of the wave function'). Which outcome becomes reality is a purely random process. This is something that notoriously

Einstein didn't like at all, and that prompted him to declare that "God doesn't play dice."

Moreover, it turns out that quantum theory is also a 'contextual theory,' meaning that the results of our measurements not only fluctuate but also depend on how we set up an experiment that provides us with information about the quantum system (such as the position of a particle, which slit it went through, its momentum, its energy, etc.). For example, in certain experimental contexts, we will observe a particle-like behavior while in other contexts a wave-like behavior, of the very same object (a photon, an electron, etc.) with the very same initial conditions. This is the famous 'wave-particle' duality. For example, if you don't try to extract from the system the information about which slit an electron went through a plate with two slits, it will displace itself on a distant screen according to a statistical distribution that shows up with interference fringes—that is, it behaves like a wave.

If, however, one positions a detector at one of the two slits to control whether a particle passes through it, then the interference fringes disappear and the particle behaves like a point moving in space. The act of measurement 'collapses' the wave function from a wave representation to a point-like particle.

The wave-like or point-like behavior depends on what information we have about the system and that can be read out by machines, without any necessity for human observers. This is what is meant by saying that QP is a 'contextual theory', contrary to Newtonian classical mechanics, which is 'non-contextual,' because in the macroscopic world things' properties don't depend on how we observe them (for example, the size, color or shape of an object does not depend from which angle we look on it.). Or, to put it in terms of the famous physicist Eugene Wigner, in the quantum realm, Nature answers according to how we frame a question. This

is what physicists have shown to be the case with endless laboratory experiments. However, Wigner spoke also about the “participatory universe,” meaning that we are part of this universe observing itself and, by our observations, are participating not only in the observation but also in determining its history. This is one of Wigner’s sidenotes that sparked so much sympathy among idealists and supporters of the “consciousness causing collapse”-theory.

There are also several other effects, such as quantum entanglement and the superposition of quantum states (for example, a particle seemingly being in two places at once), that suddenly 'collapse' from an indeterminate to a determinate state. For instance, the entanglement of particles as a single quantum entity 'collapses' into two distinct particles at the time of measurement, or a particle in multiple positions simultaneously 'collapses' to a definite position once measured.

The question then is, how should we interpret this ontic uncertainty and contextuality, and this ‘collapse’ from an indefinite to a definite physical state or property of a quantum system? As an effect of a conscious observer? The point is that these quantum effects are present always, even without anyone looking at the experiment, the particles, the slits, or whatever part of the quantum system or measuring device. And these effects were already present since the time of the creation of the universe. Quantum effects are the very first thing that determined the universe’s fate, long before the existence of any physical conscious observer.

Nevertheless, many try to save the ‘observer effect’ as having something to do with our mind or consciousness, pointing out that, after all, the outcome of an experiment is meaningless if not interpreted by someone. Ultimately, every measurement result

registered by a device must, sooner or later, be read out by a conscious observer. A measurement is not a measurement unless someone controls the outcome of... well, the measurement (say, you read out a number on a pointer.) And, since every time the measurement furnishes a (more or less fluctuating) different and contextual result that is caused neither by the interaction nor due to some unknown 'hidden variables' in the measured object, then some conclude that it is the observer's mind that causes the particle whizzing in one direction and the next time towards another one, causing what is technically called the 'collapse of the wavefunction' (the 'collapse' from a wave-like to a point-like behavior.)

The problem is that we even don't know if that wave, particle, or wave function is a real object or a fictitious mathematical abstract entity that tells us only something about our knowledge and the expectations we must have about the next measurement. We even don't know what really a measurement is. In the microscopic quantum world, things appear to be uncertain, contextual, in superposition, or entangled until someone measures it (or 'observes' it, if you prefer.) Then suddenly everything collapses to a point-like single particle. The question is why don't we observe these weird effects also in our macroscopic everyday life? This is, put bluntly, the so-called 'measurement problem', a conceptual loophole in quantum theory (an otherwise quite well-established theory) that didn't find a complete resolution until nowadays, and that is at the root of the much debated 'observer effect.'

According to this line of reasoning, somehow reality depends in the end on our observations and the context in which we make them. Thus, ultimately, there must be a connection between our mind, or consciousness, that 'collapses' reality to be the way it is through this weird 'observer effect.' In a sense, nothing exists until someone observes it.

This is, in simple words, what again Wigner thought to be the case. He illustrated this with a thought experiment ('Wigner's friend' thought experiment) and that has become an interpretation of QP that nowadays we find especially in the popular literature. Nevertheless, it does not receive too much favor from most physicists. Because the implications it suggests seem to go a bit too far. For example, should we go so far as to defend the idea that the entire universe came into existence only once humans (or, at least, some conscious beings in whatever galaxy) began to observe? Frankly, in my opinion, this looks like a desperate attempt to save the quantum 'observer effect' interpretation in order to preserve a paradigm that would like to connect at any cost quantum physics to human mental processes or consciousness.

More recently, especially people who believe in the observer effect, mention an experiment in Psi-research. It has been reported that subjects focusing their attention on a double-slit experiment, which is the paradigmatic experiment to illustrate quantum interference, could modify the statistics of the measured outcomes. This purportedly demonstrates how the mind influences quantum phenomena—that is, collapses the wavefunction—and is considered to be evidence for the quantum observer effect. But, even if the experiment is correct, it only shows that the mind might have telekinetic powers, not that it is responsible for quantum effects. It could equally well be that similar effects could be demonstrated with non-quantum objects, say by the ability to move a grain of sand or a feather. If such psychic abilities exist, there is no reason to connect them so straightforwardly to QP, since they may well be operative also in our macroscopic everyday non-quantum realm.

These are the facts about the infamous observer effect in QP. Of course, you must not take my word for a final truth and may

continue to believe that there is such a thing as an ‘observer effect’ because, unfortunately, also several physicists, when they speak to a popular audience, like to perpetuate this myth, that they would never mention in an academic lecture. While the von Neumann-Wigner interpretation gained significant favor among the general public, it remains an interpretation supported by only a tiny fringe minority of physicists. At any rate, please, don’t present it as a scientific fact, it was and remains wild speculation.

Having said that, let me digress with my personal (more or less wild) speculation as well. Paradoxically, I am one of those who believes that QP has something to do with consciousness, but I start from a completely different perspective. Let me unpack this.

In physics, only an exclusively scientific third-person perspective is allowed. The ‘observer’ is just a dead, unconscious, and mechanical measurement apparatus that registers data without any need for us to know what the result is.

This is how science is supposed to work. However, the interpretation of scientific facts depends heavily on our belief system, ideological background, and personal preferences.

If you are a materialist, or reductionist who believes there is nothing other than blind and purposeless (more or less random) phenomena ruling the universe with our conscious experience and mental phenomena being only evolutionary emergent surface epiphenomena of brain activity, you might prefer this third-person interpretation: There is no ‘observer effect’ to begin with. In QP phenomena can be driven by blind chance, just ‘random’ (whatever that means) events. We don’t need to inject ‘observers’, ‘minds, or ‘consciousness’ into a rock-solid quantum theory that never mentions it. Any further philosophical extrapolation is unnecessary metaphysical speculation.

This worldview, however, does not answer the question of wherefrom the ‘causeless’, apparently self-determining, and intrinsic quantum randomness comes from. It simply labels quantum theory a ‘theory without hidden variables’ and does not question this state of affairs further.

On the other side, if you find the attempt of reducing mind, life, and consciousness—that is, ourselves—to mere mechanistic processes unconvincing, you might lean towards more metaphysical speculations and those interpretations that see in QP the proof that reality comes into existence because of conscious observers and consciousness itself as a fundamental, non-derivative entity. It is the observer that determines reality, and the universe exists because we are observing it.

This is a perspective that sounds appealing, especially to those who embrace some sort of philosophical idealism. While I put myself in this latter category, I find this a view of extreme philosophical idealism, an almost solipsistic understanding of reality, and that, as I have just pointed out, has no real support in QP. While, I find it much more reasonable to take a third position that is potentially able to connect both, and even transcend them both. A view I termed ‘quantum idealism’ that tries to get the real message that QP is sending us.

The point is that the way we perceive and conceive reality, even on the macroscopic scale of Newtonian physics, is a reconstruction, a figment, a ‘symbol’ *in* our conscious experience filtered and translated by mental representations. That kind of reality we conceive of through our limited human sensory means doesn’t exist in the first place. No more and no less than a shadow ‘exists’ in relation to the object that projects it.

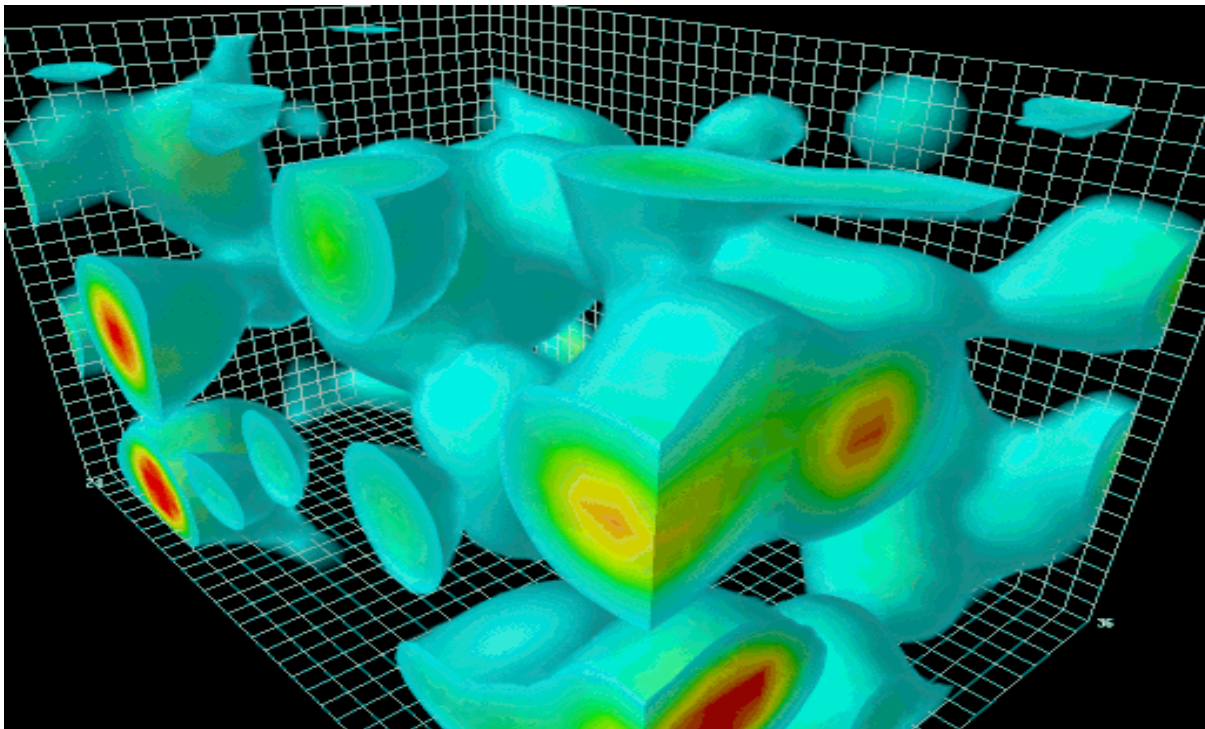
QP reminds us that the ‘shadows’ we experience in our everyday life (chunks of hard matter, particles having precise positions and momenta, etc.) do not exist ‘down there’ in the microscopic quantum realm because they don’t exist, as-we-perceive-them, also not in human’s macroscopic everyday reality. We try to inject our human-centric mental constructs into all of Nature in terms of space, time, and causality, and then, once paradoxes arise, postulate whether reality might come into existence only once we observe it. There is a ‘reality’, but it has nothing to do with the conceptual reality in our mind. That mental kind of reality doesn’t exist even when one observes it. It was and will forever remain a ‘shadow’ in our minds. Thus, it isn’t surprising that the microworld doesn’t reflect our macro-world conceptions, because there is no reason to believe that the latter has any ‘ontological superiority’ that supposedly must stand above the former. You can’t describe, let alone explain, the nature of an object with the shadow it projects.

But, again, what about that intrinsic uncertainty, indeterminacy, and randomness that is so characteristic in so many quantum phenomena? What should we make of these ‘fluctuating shadows’ then? We might agree that everything we apprehend and comprehend is ultimately a construct and a figment in us, not the ‘things in itself’, as Kant would have said. Nonetheless, why should that mental construct jitter and wobble like mad, apparently ruled by blind chance, every time we make a measurement?

Let’s take a less anthropocentric perspective and shift from the human-centric observer to a universal-centric one. Is it rather Nature making ‘choices’ that we interpret as ‘random’ due to our limited cognitive ability to see all the phenomena in their entirety? Can we then eventually go so far as stating that, not only the interaction between a measuring device and a quantum object is a

measurement, but every physical interaction between particles in the universe is a sort of *conscious* ‘measurement’ as well?

From a more cosmic perspective: not our human mind or consciousness determines the random quantum outcomes, but a will, or a working universal Consciousness in things, that, by an exclusive concentration in space and time causes one quantum event to become actual rather than another one. For whatever reason that we still don’t understand, it becomes more evident at a microscopic rather than macroscopic scale (the measurement problem.) But we don’t need to pursue dubious conjectures about observer effect in QP that determine the outcome of an experiment. We only need to question our ingrained principles of mechanistic causality and shift our reference frame from the little human perspective to a universal and teleological point of view.



The so-called ‘quantum random fluctuations.’

Without pretending to be able to have a God’s eye view of reality, it is plausible to conjecture that all that quantum randomness and all

that mysterious quantum fluctuations are ‘potentialities,’ ‘latent possibilities,’ a ‘power of choice,’ that come into being by the works of a ‘self-determining Mind at large.’ A ‘super-mind’ that works in and throughout the whole universe, in and through the tiniest elementary particle in every point in space and time (for more on this see also my essay on “force, will, and agency.”) Something that, by the way, would be well in line with modern quantum field theories that work with the notion of a universal quantum field. We, as cognitively limited beings, can interpret all this work no other than as being ‘random,’ and ruled by what we call ‘chance.’ But also the ordered and purposeful design of an artifact or a machine created by a human being might well appear a chaotic, and meaningless entity ruled by chance to an ant that can’t look further than its anthill.

So, I agree with Einstein. But for very different reasons than he had in mind. In fact, God doesn’t play dice. God is the dice and even tosses itself.

What Is The Observer Effect In Quantum Mechanics?

by [Venkatesh Vaidyanathan](#)

Quantum mechanics is the study of how particles at the atomic and subatomic level interact with each other and their environment. The observer effect is the phenomenon in which the act of observation alters the behavior of the particles being observed. This effect is due to the wave-like nature of matter, which means that particles can exist in multiple states simultaneously. When an observer measures a particular property of a particle, they are effectively collapsing the wave-function of that particle, causing it to assume a definite state.

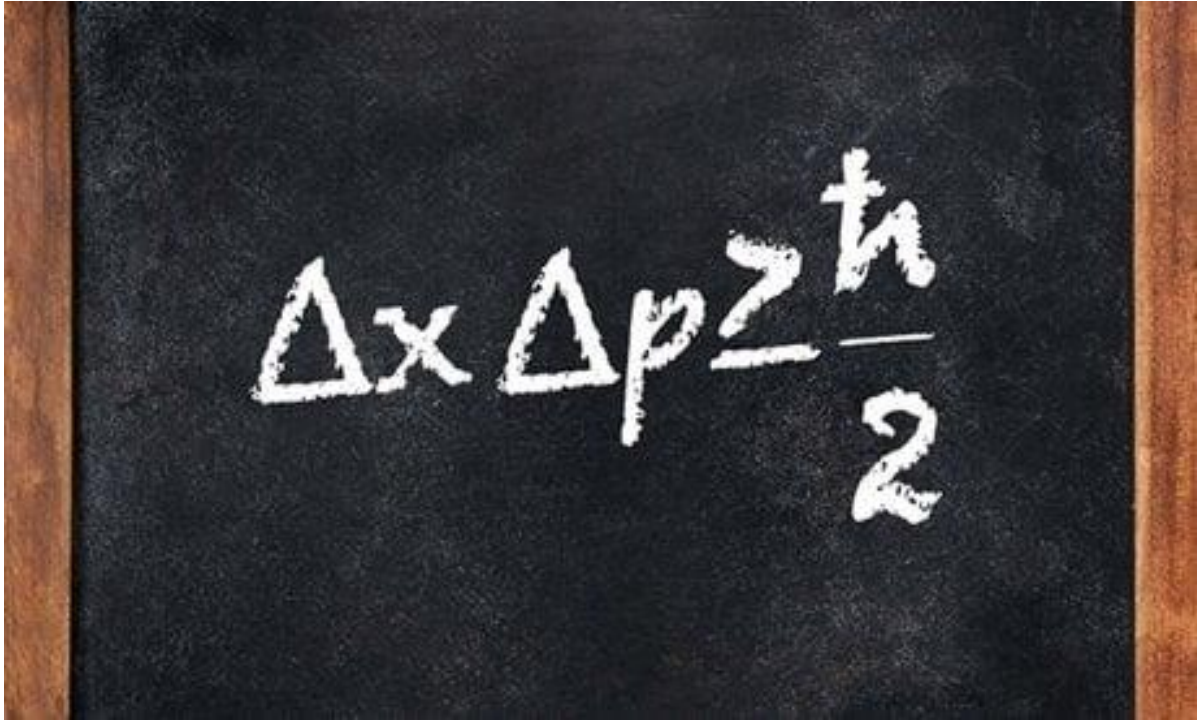
When you observe something in the world—a tree, a bird or anything else—you know that regardless of where and when you observe the object, it will always remain the same. However, what if I told you that the time and manner you looked at a particular bird would affect its appearance? It sounds quite absurd, but absurdity is normal when it comes to the bizarre laws of the quantum realm. The laws of quantum mechanics work very differently than the physics of the regular-sized world. Before we get into understanding the observer effect, let's first take a look at the fundamentals of [quantum physics](#).

The Fundamentals

The field of quantum mechanics was primarily founded on three pillars. The first of these pillars is known as **Quantized Properties**. Quantized properties give the position, speed, color and other properties of a particle that can only occur in set amounts of time and instances. This is in direct contrast to the belief held in the well-established field of Classical Mechanics, namely that everything happens in a smooth and continuous spectrum. This was something that scientists found to be highly novel and ended up naming these particles Quantized Particles. The second pillar of Quantum Mechanics refers to the **particle nature of light**. At first, the notion that light could behave and be classed as a particle ran into colossal criticism, as it ran against the well-established principle that light had a wave-like nature to it.

However, the particle nature of light brought in a fundamental unit that could represent tiny energy packets, known as **quanta**. This was proposed by none other than Albert Einstein himself. Einstein hypothesized that a packet of energy could either be generated or absorbed, as a whole, specifically by an electron that wants to jump from one quantum state to another. The third and final fundamental pillar of Quantum Mechanics is the **wave nature of matter**. Although this might be hard to digest, matter also exhibits a wave-like nature. The wave-like nature of matter was proposed by two scientists independently, at nearly the same time, despite being oblivious of each other's work. These two erstwhile discoverers were scientists Louis De Broglie and Erwin Schrodinger. They used two fundamentally different mathematical approaches to prove the wave-like nature of matter. Later on, both men were credited for their contributions and their idea was jointly named the Heisenberg-Schrodinger model. Heisenberg did make one more crucial contribution to Quantum Mechanics. While not as essential as the fundamental pillars, it did play a significant role and is known as **Heisenberg's Uncertainty Principle**. He reasoned that since the nature of matter is wave-like, some properties, such as the velocity and position of electrons, are complementary to one

another. In simpler terms, there is a limit up to which each property of an electron can be simultaneously measured with a degree of accuracy.



Heisenberg's Uncertainty Principle

Observation Affects Reality

When a quantum 'observer' is watching, Quantum Mechanics states that particles can also behave as waves. This can be true for electrons at the sub-micron level, i.e., at distances measuring less than one micron, or one-thousandth of a millimeter. When behaving as waves, electrons can simultaneously pass through several openings in a barrier and then meet again on the other side. This meeting is known as **interference**. Now, the most absurd thing about this phenomena is that it can only occur when no one is observing it. Once an observer begins to watch the particles going through the opening, the obtained image changes dramatically: if a particle can be seen going through one opening, it is clear that it did not go through another opening. In other words, when under observation, electrons are more or less being forced to behave like particles instead of waves. Thus, the mere act of observation affects the experimental findings.



Erwin Schrodinger & Heisenberg(Photo Credit : Nobel foundation /Wikimedia Commons)

To demonstrate this phenomena, the Weizmann Institute built a tiny device, less than one micron in size, that had a barrier with two openings. They then sent a current of electrons towards the barrier. The observer in this experiment was not human. Instead, they used a tiny electron detector that could spot the presence of passing electrons. The quantum “observer’s” capacity to detect electrons could be altered by changing its electrical conductivity, or the strength of the current passing through it. Apart from “observing,” or detecting the electrons, the detector had no effect on the current. Even so, the scientists found that the very presence of the detector “observer” near one of the openings caused changes in the interference pattern of the electron waves passing through the openings of the barrier. In fact, this effect was dependent on the “amount” of observation: when the “observer’s” capacity to detect electrons increased, in other words, when the level of the observation went up, the interference weakened; in contrast, when its capacity to detect electrons was reduced, and the observation slackened, the interference increased. Thus, by

controlling the properties of the quantum observer, the scientists managed to control the extent of its influence on the electrons' behavior!

Observer (quantum physics)

Some [interpretations of quantum mechanics](#) posit a central role for an **observer** of a quantum phenomenon.^[1] The quantum mechanical observer is tied to the issue of [observer effect](#), where a measurement necessarily requires interacting with the physical object being measured, affecting its properties through the interaction. The term "observable" has gained a technical meaning, denoting a [Hermitian operator](#) that represents a measurement.^{[2]:55}

Foundation

The theoretical foundation of the concept of [measurement in quantum mechanics](#) is a contentious issue deeply connected to the many [interpretations of quantum mechanics](#). A key focus point is that of [wave function collapse](#), for which several popular interpretations assert that measurement causes a *discontinuous change* into an [eigenstate](#) of the operator associated with the quantity that was measured, a change which is not time-reversible.

More explicitly, the [superposition](#) principle ($\psi = \sum_n a_n \psi_n$) of quantum physics dictates that for a wave function ψ , a measurement will result in a state of the quantum system of one of the m possible eigenvalues f_n , $n = 1, 2, \dots, m$, of the operator $\wedge F$ which is in the space of the eigenfunctions ψ_n , $n = 1, 2, \dots, m$.

Once one has measured the system, one knows its current state; and this prevents it from being in one of its other states—it has apparently [decohered](#) from them without prospects of future strong quantum interference.^{[3][4][5]} This means that the type of measurement one performs on the system affects the end-state of the system.

An experimentally studied situation related to this is the [quantum Zeno effect](#), in which a quantum state would decay if left alone, but does not decay because of its continuous observation. The dynamics of a quantum system under continuous observation are described by a quantum [stochastic](#) master equation known as the [Belavkin equation](#).^{[6][7][8]} Further studies have shown that even observing the results after the photon is produced leads to collapsing the wave function and loading a back-history as shown by [delayed choice quantum eraser](#).^[9]

When discussing the wave function ψ which describes the state of a system in quantum mechanics, one should be cautious of a common misconception that assumes that the wave function ψ amounts to the same thing as the physical object it describes. This flawed concept must then require existence of an external mechanism, such as a

measuring instrument, that lies outside the principles governing the time evolution of the wave function ψ , in order to account for the so-called "[collapse of the wave function](#)" after a measurement has been performed. But the wave function ψ is *not a physical object* like, for example, an atom, which has an observable mass, charge and spin, as well as internal degrees of freedom. Instead, ψ is an *abstract mathematical function* that contains all the *statistical* information that an observer can obtain from measurements of a given system. In this case, there is no real mystery in that this mathematical form of the wave function ψ must change abruptly after a measurement has been performed.

A consequence of [Bell's theorem](#) is that measurement on one of two [entangled](#) particles can appear to have a nonlocal effect on the other particle. Additional problems related to [decoherence](#) arise when the observer is modeled as a quantum system.

Description

The [Copenhagen interpretation](#), which is the most widely accepted [interpretation of quantum mechanics](#) among physicists,^{[1][10]:248} posits that an "observer" or a "measurement" is merely a physical process. One of the founders of the Copenhagen interpretation, [Werner Heisenberg](#), wrote:

Of course the introduction of the observer must not be misunderstood to imply that some kind of subjective features are to be brought into the description of nature. The observer has, rather, only the function of registering decisions, i.e., processes in space and time, and it does not matter whether the observer is an apparatus or a human being; but the registration, i.e., the transition from the "possible" to the "actual," is absolutely necessary here and cannot be omitted from the interpretation of quantum theory.^[11]

[Niels Bohr](#), also a founder of the Copenhagen interpretation, wrote:

all unambiguous information concerning atomic objects is derived from the permanent marks such as a spot on a photographic plate, caused by the impact of an electron left on the bodies which define the experimental conditions. Far from involving any special intricacy, the irreversible amplification effects on which the recording of the presence of atomic objects rests rather remind us of the essential irreversibility inherent in the very concept of observation. The description of atomic phenomena has in these respects a perfectly objective character, in the sense that no explicit reference is made to any individual observer and that therefore, with proper regard to relativistic exigencies, no ambiguity is involved in the communication of information.^[12]

Likewise, [Asher Peres](#) stated that "observers" in quantum physics are

similar to the ubiquitous "observers" who send and receive light signals in [special relativity](#). Obviously, this terminology does not imply the actual presence of human beings. These fictitious physicists may as well be inanimate automata that can perform all the required tasks, if suitably programmed.^{[13]:12}

Critics of the special role of the observer also point out that observers can themselves be observed, leading to paradoxes such as that of [Wigner's friend](#); and that it is not clear how much consciousness is required. As [John Bell](#) inquired, "Was the wave function waiting to jump for thousands of millions of years until a single-celled living creature appeared? Or did it have to wait a little longer for some highly qualified measurer—with a PhD?"^[14]

Anthropocentric interpretation

The prominence of seemingly subjective or [anthropocentric](#) ideas like "observer" in the early development of the theory has been a continuing source of disquiet and [philosophical](#) dispute.^[15] A number of new-age religious or philosophical views give the observer a more special role, or place constraints on who or what can be an observer. As an example of such claims, [Fritjof Capra](#) declared, "The crucial feature of atomic physics is that the human observer is not only necessary to observe the properties of an object, but is necessary even to define these properties."^[16] There is no credible peer-reviewed research that backs such claims.