Free Will and Quantum Indeterminacy

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From observing the natural world, classical physics has derived a set of rules that provide a deterministic framework, from which, the material world cannot deviate. Leading to the inevitable conclusion that the universe is governed by cause and effect; every event happens precisely as it does (and does not happen any other way) because the preceding events are directed into the present by the laws of physics. Contrary to the meticulous determinism of classical physics, the mysterious nature of quantum mechanics suggests that the universe is fundamentally indeterministic. This raises important questions about human nature; particularly, is there room for free will in a universe so strictly governed by the laws of physics? The answer hinges on how one defines free will and there are at least two ways to do so. The simplest and most obvious is in subjective terms. We experience ourselves freely making decisions every day; choosing to eat an apple instead of an orange is a seemingly obvious display of free will, as there is nothing external to the agent blatantly coercing the decision. There is no doubt that human life entails free will as a description of the experience. On the other hand, we can define free will objectively: an account of how an entity consciously alters its course in the physical world. If we strip away all the subjective human filters, through which one perceives reality, is it still she who is the source of her decisions and the author her thoughts?

The objective view of freedom is what most people intuitively take to be true and it is what the optimists should want to defend because it is an absolute necessity for free will to amount to anything more than an illusion. I argue that an objective account of free will is impossible; a thorough understanding of contemporary physics dismantles the aforementioned intuition and effectively raises determinism into fatalism. There is a feeling of choice that

accompanies every conscious decision, which contradicts with the scientific theories of universal causation; all events are links in a deterministic chain, even mental events.[1] The fallacy that many are guilty of is extrapolating the subjective experience of free will into an objective truth. Although we may lack the ability to perceive determinism conducting our lives, this is not grounds to dismiss determinism but rather to acknowledge our imprisonment by human subjectivity.

When talking about free will, it is important to consider its association with moral responsibility because the two concepts are tightly connected. Moreover, the word "responsibility" communicates different concepts when used in different contexts. There is responsibility of the kind to which we, as a collective society, hold each other accountable for our actions. This notion of responsibility operates as a societal utility for the foundation of jurisprudence and perhaps morality itself. With it, we can justly put a criminal in prison by the collective agreement that she is responsible for her decisions and actions; it is an after the fact attribution of responsibility onto the person. This differs from the concept of responsibility I argue from, which is better phrased as *"ultimate moral responsibility"*. Responsibility in this context is a matter of an individual being the source of one's mental state; to take complete responsibility for one's decisions, one must be the ultimate source of the decisions, and the decisions must not be attributable to external influences.[2] One's position on free will may be defined by their beliefs about the relationship between free will and moral responsibility, but

[1] Henry Margenau, "Quantum Mechanics, Free Will, And Determinism." *The Journal of Philosophy,* Vol. 64, No. 21 (1967): 716.
[2] Galen Strawson, "The Impossibility of Moral Responsibility." *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition,* Vol. 75, No. 1 (1994): 6.

there seems to remain the irreducible notion that for one to be morally responsible, they must have some degree of freedom.

It would be imprudent to write an essay regarding physics, let alone quantum physics, and not articulate exactly what is meant by the words specific to the field. *Newtonian physics* and *classical physics* are synonymous; they are the amalgamation of everything we learned in physics until the early 20th century when quantum mechanics initiated. *Quantum mechanics* and *quantum physics* are synonymous; they are the study of the physics to do with subatomic particles. Concerning the distinction between the *microscopic* or *microworld* and the *macroscopic* or *macroworld*, the atom is where we draw the line between the two. The atom itself and anything that is constituted by a collection of atoms is a macroscopic entity; the subatomic particles like electrons, quarks, bosons, and all other particles that are smaller than an atom are microscopic entities. And for my usage, *particle* is synonymous with *subatomic particle*. The first quantum hurdle to jump is *superposition*: instead of a particle having one particular position or velocity, the quantum state of a particle is in a superposition of all its possible positions and velocities. The superposition of a particle is defined by its *wave function*, which refers specifically to the concept in quantum mechanics used to represent the probability of all possible results one might get if one were to measure for a specific quality of a particle. It is a mathematical representation of probability as a function of some measurement. If one were to measure for say the position of a particle, the particle has a wave function that represents the probability for each possible result the measurement may yield. Therefore, a particle in its quantum state exists as a wave and not as a very tiny sphere-like object as we might typically have been taught to imagine. However, when we observe a particle, that is if we take a measurement, the wave function collapses and we observe a single measurement out of all the

possible measurements that could have been observed. *Quantum entanglement* is a phenomenon that occurs between multiple particles. Say we have one particle in an isolated system; its wave function describes all its possible positions. Then we add another particle to the system that has its own wave function describing all of its possible positions. Due to the two particles being in the same system, they become entangled and form a single wave function to describe all the possible positions of each particle relative to the other. To demonstrate the idea more tangibly, suppose we have two particles referred to as particle A and particle B that are entangled together in a system. If we were to measure for the position of a particle A and thus collapsing its wave function, we consequently collapse the wave function of particle B *and* the position we measured particle A to be in is indicative of the position of particle B. The collapse of particle A's wave function causes the simultaneous collapse of particle B because they are entangled.

The immense measurability, predictability, and consistency of Newtonian physics has effectively dismantled the common notion of objective free will. If we, conscious agents, are material entities, then it follows that our material aspect is subject to the classical laws of physics; these laws strictly dictate reality from the movement of celestial bodies down to the level of the atom. This Newtonian determinacy was first formalized in a thought experiment by Pierre-Simon Laplace and is commonly referred to as *Laplace's Demon*: If a hypothetical super-being were to know the exact position and momentum of every atom in the universe then, through the use of the classical laws of physics, it could calculate and predict everything that is going to happen as well as everything that has happened in the past. The magnitude of the required calculation is far beyond the capability of modern humans, but the theoretical implications of this postulate render free will impossible. The human brain, or the human body as a whole, can be accurately described as a collection of atoms; therefore, all the neurological

mental activity within the brain is reducible to atoms simply doing what atoms do as dictated by the laws of physics. The universe plays out in exact accordance to the laws of physics, regardless of whether or not fully understand all the laws at this point in history. The infallible clockwork of Newtonian physics, if taken seriously, pushes determinism into fatalism.

This carries a profound implication: any instance you can think of from your life where you unhinderedly made a decision from genuine options was merely the subjective experience of freedom—not objective free will. You as an agent, had no actual control over a decision because any amount of forethought, rational contemplation, moral deliberation, every desire, every inhibition, every thought that crossed your mind is reducible to electrical activity happening in the material structure of your brain and operating exactly as dictated by the laws of physics. Experiencing a sensation of control does not equate to exercising control. If we accept the materialists view, then the thoughts we claim to author suddenly become predictable and determined—fatalistic. The objective notion of freedom we entertain would certainly dissolve if the Laplacian demon was sitting across from us, speaking our every thought just momentarily before we think it. Simply because the demon fully understands exactly how the neurological activity in one's brain and how each atom that constitutes one's body, is being directed by the laws of physics.

Galen Strawson puts forward the argument that the decision you make is determined by the mental state of your brain at the time of being faced with the decision; the mental state of your brain is determined by your genetic inheritance and the amalgamation of your life experiences that lead to that moment of decision—both of which are things that you can in no

way be ultimately responsible for.[3] No one has ever gotten to choose their parents or the genetics inherited from them, the time in history or part of the world they were born into, or the social and psychological conditions of their upbringing, but these are all things we should agree have a great influence in shaping an individual and thus shaping the kinds of decisions that they make. Every thought or action one expresses and every quality or characteristic that one may attribute to what makes one *who they are* is connected to prior influence (whether it be physical, psychological, social, or cultural) external to the self.[4] That is to say, every reason that could possibly be given for why an agent made a particular decision and why they did not choose otherwise is traceable to a source beyond the agent's domain of influence—beyond their control.

One may argue against the fatalist implications of Newtonian physics by pointing to the indeterministic nature of quantum mechanics. We can look at the universe at the atomic resolution and say that it operates in a deterministic manner. Or we can also look at the universe at a slightly finer resolution, in terms of subatomic particles, and suggest that on a more fundamental level the universe is indeterministic due to the probability intrinsic to the wave function. It is certainly true that many qualities of the microworld operate probabilistically and thus, indeterministically; consequently, we cannot accurately predict the behavior of subatomic particles using classical physics. At this juncture, we are faced with a glaring question: does the probabilistic behavior of the microworld translate into probabilistic behavior of the macroworld? The short answer is no. No matter how mysterious and misunderstood quantum mechanics could be at this moment in history, the predictability of the macroscopic world remains fully intact because of its emergent properties.

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[3] Galen Strawson, "Free Will" *Routledge encyclopedia of philosophy. London: Routledge* (1998).
[4] Helen Perlman, "Self-Determination: Reality or Illusion." *Social Service Review*, Vol. 39, No. 4 (1965): 412.

In physics we sometimes like to reduce the picture down to an atomic or molecular resolution. For Laplace's demon to be able to make any prediction, of the infinitely many predictions that could be made, it requires knowledge of the position and momentum of each individual atom in the entire universe. For us non-demons this means that to make a prediction, we need all the *relevant* information. Say if we were to pick one air molecule in the room and we wanted to figure out exactly what will happen to it over the next five seconds, it is necessary that we know the initial position and momentum of the subject molecule and of each molecule that will be involved in the chain of collisions that impact the subject molecule over the specified five second time duration. However, emergent properties are not like this and they constitute a large portion of Newtonian physics. Emergence describes the collective behavior of a large number of microscopic constituents that is qualitatively different than the behaviors of the individual constituents.[5] The hardness of a diamond is an emergent property because the carbon atoms individually do not have the quality of being hard, it is their particular arrangement that gives rise to this property. The Earth's orbit around the sun is an example from astrophysics: to make an accurate prediction, we do not need to know the position and momentum of each individual atom that the Earth consists of; all we need is the position and velocity of the center of mass of the Earth and of any other nearby influential gravitational forces, like the Sun. Anything happening in the microscopic world is completely irrelevant in making this kind of prediction. The conclusion to be drawn here is that Newtonian predictability in the macroworld is in no way reduced by the probabilistic workings of quantum mechanics.

So how does this relate to free will? By asking if our thoughts and consciousness are emergent properties of our brains. The current picture drawn by neuroscience suggests that our

[5] Sophia Kivelson and Steven Kivelson, "Defining emergence in physics." *npj Quantum Materials* 1, No. 1 (2016): 1.

mental life consists of an autonomous, coherent flow of mental states (beliefs, desires etc.) seemingly arising out the biochemical activity among the neurons in our brains.[6] The subjective aspect of free will is obvious but, the existence of objective free will hinges on whether or not neuroscience can reduce these mental phenomena down to being purely electrical activity within the macroscopic structures of the brain. If consciousness and thoughts can be reduced in such a way, then free will cannot logically exist as an objective truth because the mental activity of one's brain falls in the domain of classical physics and is therefore fully predictable. In this case, free will is simply an illusion caused by observing and experiencing our self-determination. That is to say you will, of course, experience your decision as determined by *you* but, the decision is traceable back in time through a direct cause and effect relationship to subconscious events that you are in no conceivable way able to control.

Though, it may also come to be the case that consciousness cannot be explained purely through macroscopic science; that a complete explanation of mental activity may actually require quantum mechanics, as the orbital path of Earth does not. The fatalistic case that I have put forward could be rendered false if a case could be made for consciousness manifesting outside the bounds of classical physics and without alluding to the supernatural—perhaps at the quantum level. This could at the very least attribute probability to the will but, most importantly, it would remove the will from a fatalistic framework in which it is certainly not free. This idea is not necessarily new, perhaps new to the scientific community because it has a history of being used in a pseudo like manner and certainly not by physicists. To the general public, quantum mechanics has had a tendency of being over simplified and misconstrued to argue beyond its

[6] Bedau, Mark A, "Weak emergence." Noûs 31 (1997): 375.

domain. A generic misinterpretation of quantum mechanics is to cite a few facts, then draw an illogical conclusion and this can be done to attempt an argument for free will.

For example:

i. It is true that an isolated particle (say the electron of a hydrogen atom) has a wave function that represents its properties.
ii. It is true that a human (with their own cumulative wave function) would entangle themselves with the electron if they entered the system, thus merging wave functions into a single wave representing the system as a whole.
iii. It is true that if a measurement was made by the human, say to measure the position of the electron at some point in time, the wave function would collapse and a single position would be observed.
iv. Yet, the probabilities articulated by the wave function of the system are *influenced* by the entanglement between the human and the electron.

The wrong conclusion to draw here is that if the will can be rooted to the quantum level, it would shape the humans wave function and consequently the observer, due to the entanglement between themself and the particle, changed the particle's wave function; that it was the observer who changed the electron. This is not true and its falsity is irrelevant to the source of consciousness. The wave function of the system has to represent each possible position of the electron *and also* each possible quantum state of the human. The human changed the wave function of the system, not of the electron. The wave function of the electron on its own is unaffected by the entanglement, rather it is a portion of a larger wave function that represents the whole system. Therefore, the entanglement between the two entities did not add or remove any probabilities or possible positions for the electron to be in; it simply added that the electrons

wave function may collapse to be in a particular position *and also* the humans wave function may simultaneously collapse and assume a particular state. This is a common confusion when quantum mechanics is applied outside the context of physics because it manipulates the definitions of *entanglement* and *wave function* to be misconstrued as *changing an object* when this is in fact not true—the observer did not change the electron by the entanglement between them.

Moreover, if we consider another context wherein we begin with single particle and then add another particle to the system, then we can add another, and another; each step changing the wave function of the system, but eventually building it up to a system that represents a realistic object—such as a brain that thinks and makes decisions. This scenario launches us directly at the wall of quantum decoherence, which is the loss of quantum phenomenon due to interaction with the environment—from a lack of isolation. Currently, there are only a handful of labs in the world capable of doing quantum research because actually getting quantum mechanics to operate for any reasonable length of time so it can be observed requires placing particles in the emptiest possible vacuum and as close to zero Kelvin as possible (around fifteen thousandths of a degree above absolute zero.) The consequence of quantum decoherence is that the indeterminacy exhibited by subatomic particles becomes increasingly irrelevant proportional to the lack of isolation; that is, the quantity of particles in a given system. Asserting the operation of quantum mechanics in a brain becomes rather absurd when considering the enormous quantity of subatomic particles in a brain.

This leads us to one of the greatest hurdles of quantum mechanics: What we *see* when we observe the world and what the world actually *is* are fundamentally different. The electron is not a particle in the typical understanding as a tiny sphere at an explicit point in space; what exists in

reality is the wave function, the probability distribution, exhibiting wave like behavior as observed in the infamous double slit experiment. Until of course, observation collapses the wavefunction (what actually qualifies as an observation is an entirely separate topic.) It is for this reason that we no longer describe the electron as a particle orbiting around a nucleus, analogous to the planets orbiting the Sun. Instead, we describe the electron as a cloud of probability that exists around the nucleus. [7]

If we take Newtonian physics seriously and appreciate it for what it is then we must acknowledge that it makes flawless predictions for all objects ranging in size from atoms to galaxies. If we want to defend free will as something more substantial than illusory subjective experience, we need to identify what specific quality humans possess that removes us from this predictive framework. Typically, we turn to consciousness for this quality, and perhaps there is some undiscovered source of consciousness grounded somewhere deep in the mist of quantum mechanics but, there is currently no foundation to support this. Moreover, before this could even hope to be established, the scientific and philosophic communities need to come to a consensus on the definition of consciousness. It can be defined in such a way that a dandelion is conscious or defined in such a way that an infant is not conscious. The inability to agree on a precise definition has preserved consciousness from the true scrutiny of the scientific method; the kind of scrutiny required to uncover any unknown objective facts like what it is and where it comes from. A critical analysis of reality unveils a minimal set of posits (well-connected constructs) that render our experience, including the experience of freedom, coherent[8] Without a rigorous definition, consciousness could merely be a manifestation brought about by electrical current

[7] Sean Carrol, *Something Deeply Hidden* (London: Penguin Random House, 2019), 18-19.

[8] Henry Margenau, "Quantum Mechanics, Free Will, And Determinism." *The Journal of Philosophy,* Vol. 64, No. 21 (1967): 717.

moving through an extremely complex circuit board. The apparent lack of such a transcendent quality, leaves me no other alternative than to conclude that the part universe we exist in is fatalistic.

It was over two hundred years ago that Dr. Samuel Johnson said: "All theory is against the freedom of the will; all experience for it."[9] All empirical information alludes to the notion that we do not have the authentic freedom and control we feel we have; rather, we have an innate capacity to articulate the story surrounding an event, in which, free will is an adjective to the human experience. If one were to ask what it is like to be human, part of the answer must include that a human does feel as though they author their thoughts and they are the original source of their decisions and actions. Free will may not exist objectively, in terms of how the universe transitions from one physical state to the next. However, it may be more relevant to us non-demon humans that the belief in free will, the subjective experience of freedom, is relatively paramount to the objective as it is a profound and crucial illusion fundamental to human interaction. As an illusion, it is an immeasurably useful, abstract concept that humans have utilized as a foundation for lawful society—an illusion necessary for our collective evolution.

[9] John Russell, *The Life of Dr. Samuel Johnson* (London: J. Burns, 1847), 194.

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