

# Quantum Physics 102

## The Heisenberg Uncertainty Principle

I am a fairly active member of a yahoo group called theoretical physics. In this group, we explore a lot of different abstract paths in physics, and as such, it makes us the target of many blogs by those who know everything. In one such blog, I have been quoted, quite out of context that I was against the HUP and held to a stoically classical interpretation of Physics. Of course those of you who have talked with me personally, or listened to some of my podcasts or radio interviews, know that this simply isn't the case. I do believe in thought experiments, and in examining the accepted rules, calling them into question and holding them to their proposed truths. In the process of this procedure, everything gets thrown into the stew pot. Having said all of that, Quantum Mechanics is all about probability. Specifically, there is the possibility of finding a particle at a particular place at a particular time. The Heisenberg Uncertainty Principle states that there is an uncertainty in position of any subatomic particle, and that both the position and the speed cannot be simultaneously known with complete accuracy. So far, no discovery has cancelled out this notion. Before writing this, I discussed this with several friends, including Dr. Hans van Leunen, because I wanted to get this down as accurate as possible: The Heisenberg uncertainty relation is determined by the fact that two canonical conjugated operators are related via a Fourier transform. The Fourier transform is pure mathematics. So the only reason to doubt Heisenberg's Uncertainty Principle would be if position and momentum are not each other's canonical conjugates.

The Heisenberg Uncertainty Principle is most often glued to the measuring process. We could explode it using decoherence. If you want to determine position accurately, then you must annihilate entanglement in an act of decoherence. Only after eliminating entanglement could you accurately measure position. If in the next step you want to determine momentum, then you must reverse the decoherence step with a recoherence step. If you represent the physical item by a Hilbert subspace then in the decoherence step you batter the subspace such that is nearly completely flat with respect to momentum space. In the recoherence step you batter the subspace until it is flat in the position space. This of course will strongly influence the observed subject. And, if you accept a certain "blurriness" of the measurement, then you don't have to pelt it that much. It might be that

you don't have to batter at all. In the last case the item can stay unaltered. But alas, we have traveled in a circle to a dead end. Heisenberg's Uncertainty Principle still reigns. Only when a physical item can be represented by a single vector rather than by a multidimensional subspace, will it be possible that Heisenberg's Uncertainty loses its power. Quantum logic says that physical items can be represented by closed Hilbert subspaces. It does not say that these subspaces are multidimensional, but a bit of reasoning makes clear that even for elementary particles the subspaces are multidimensional. (Wave functions can be represented by a single Hilbert vector, but these vectors characterize the item rather than represent it). Fields cannot be represented by a closed Hilbert space. So until someone proves that we are just two-dimensional cartoons in a cosmic video game, my money is on Heisenberg...

Born in 1901, Werner Heisenberg was a German physicist who studied under THE Max Born, and Nobel Prize winner Niels Bohr. He would publish his theory of quantum mechanics in 1925 when he was only 23. He himself would win the Nobel Prize in 1932 for his work on allotropic forms of hydrogen. But his principle of uncertainty would shake the world of physics to the core, by requiring a near infinite range of possibilities to describe a particle's probability of distribution.

So the world of the quantum would be defined by probability. Generally speaking, you cannot assign a definite value to an observable object in QM. You must predict the probability of possible outcomes from measuring the observable. Now your head should really be hurting. This is the meat of the whole meal.

So in essence, what may be a rational, scientific explanation of paranormal phenomena, doesn't seem so rational at all.

Neat, eh?

An eigenstate is a condition associated with an observable object. Things in this condition are definite. They have measurement value and time of occurrence. Example, you drive your kid to soccer practice on the parkway in New Jersey at 4:30 in the afternoon is a series of eigenstates. And while this may work more or less in New Jersey (in spite of horrendous traffic) in Quantumville, things simply do not work that way. Instead, there is a wide range of possible outcomes, and until the wave function is observed, and consequently collapsed, it is a complete and total crapshoot. This little gem of knowledge is called the Copenhagen Interpretation, which states that nothing is real until you observe it. Until the point of observation, reality is a potentiality, or statistical formulation. This head bender was calculated by Niels Bohr and Werner Heisenberg in 1927 (hence the Heisenberg

Uncertainty Principle), and was the evolutionary update of Max Born's Nobel Prize for statistical interpretation of the wave function. Amazingly, this is a widely held view by many mainstream physicists, that nature is probabilistic, with the "will" of the observer directly influencing the subjective reality. Are the cogs beginning to mesh yet? And they think WE deal in the paranormal!

Imagine you are investigating a reportedly haunted house that has a "quantum wave" inside it. The wave is only imaginary, a possibility existing in a vibrational quasi-state until you look at it. At the moment of our witnessing it, the wave function collapses and is manifested in our three dimensional reality as a full body apparition. But until you look at it, it remained in a spooky in-between state, a Never-Ever Land.

This is why I believe Quantum Physics will hold the answers to some of the paranormal questions. Quantum Mechanics exists upon the foundational belief that nothing can be determined about the true nature of a particle until it is observed. This implies a DIRECT LINK between the particle being observed, and the observer.

IS this cool or what? Ah...but there is much more.

### **Many Worlds Interpretation**

Not so fast! The "Nothing is real until you look at it and it becomes Something" theory has competition. The Many Worlds Interpretation states that EVERYTHING is real, even when you DON'T look at it.

Feel the pounding in your temples? It is going to get far worse....

Hugh Everett proposed this theory in 1957, in which there are worlds that split off each time a potential choice exists. This theory opened the possibilities of an infinite number of worlds existing alongside our own. The wave function collapse leading to every conceivable outcome suggests a universe constantly splitting into another version of itself each and every time an observer has a choice of all possible outcomes to a decision. While this sounds really far-fetched, recent discoveries by Dr. David Deutsch of Oxford University showed mathematically that the bush-like branching structure created by the universe splitting into parallel versions of itself can explain the probabilistic nature of quantum outcomes. It should come to no surprise that this work was attacked originally by mainstream science, but it has now had rigorous confirmation by Dr. David Wallace and Dr. Simon Saunders, also at Oxford.

Can you grasp the scope of this and what it implies?

Everytime you go to the bathroom the universe splits to accommodate you going number one or number two. Or not at all, or both. And what if you are out of paper? Another split.

Now MY head is starting to hurt.

I am trying to imagine a never ending stack of universes popping up around the one I am in and I am making a different choice in each one. This implies that there are infinite versions of me out there doing an infinite number of things. This HAS to be scary has hell to my enemies. I am observing my own life, and each time I make an observation I split into a number of copies, each in turn observing one possible result, and unaware of the others doing their thing. This continues in their universes as they move forward, and in the harmonic universes created by them, and so on, creating many real but unobservable worlds from my standpoint. The reason these worlds split is because of the loss of coherency and the absence of interference between all the various elements of the superposition.

Now here is the really cool thing.

Interactions with either the environment or a measuring device cause the wave functions of a system and the measuring device to become entangled. This is called decoherence (remember the mind candy trip above with Heisenberg?) and it happens very rapidly on a macroscopic scale, which explains our inability to observe quantum affects in everyday objects. We can't see these other worlds or have access to them because they occupy the same time and space we do, in what is called Hilbert Space, or hidden dimensions beyond our four recognized space time dimensions (again, from the above Heisenberg abstract).

While the Copenhagen Interpretation is still the reigning belief of many physicists, the many-worlds or multiverse theory is gaining ground rapidly. From our standpoint as paranormal investigators, the many worlds theory holds the key to a lot of answers. But there is a problem with the mechanics of Many Worlds. Where is all the energy and matter coming from???

### **Bells Theorem**

Particles are connected on a level that is beyond space and time. This is another clue to understanding the possible source of paranormal activity. This is a very profound discovery.

Essentially, everything is connected to everything else. Sounds metaphysical, and perhaps it is, but it is also true. Nonlocality is a reality. The whole concept of entanglement was one of the few ideas Einstein missed the boat on. If subatomic particles remain entangled, they can

affect each other at extremely vast distances and do so infinitely fast. This tears apart in a way the classical physics belief that velocity is limited to the speed of light. We know from experiments that entangled particles share a special kind of pairing of properties. Photons, for example, could utilize polarization as its special property. One photon could be polarized horizontally, and the paired photon would be polarized vertically.

Michio Kaku says in his book *Parallel Worlds: A Journey Through Creation, Higher Dimensions, and the Future of the Cosmos*, that entangled particles are somewhat like twins still joined by an umbilical cord (their wave function) which can be light years across. What happens to one member automatically affects the other...entangled pairs act as if they are a single object, although they may be separated by an extremely vast distance. Fascinating.

So this means that the photons are in a superposition, or stateless state until someone comes along and measures them, collapsing the wave function. An experimenter can then fire them out in opposite directions. Computers track the photons as one is forced through a vertical slit, and instantly the opposite photon takes on a horizontal polarization no matter where it is, and vice versa. If the first photon is forced through a horizontal slit, the opposite photon will spin vertical. Measuring one affects the other. Quantumville operates on different laws than the cosmos, and the search to unify the two worlds is the Holy Grail of Physics.

General relativity as well as classical physics is deterministic. Quantum Mechanics on the other hand is undeterministic. General relativity deals with only one of the four fundamental forces of nature, and that is gravity. QM relies on the other three; Electromagnetic, Strong and Weak nuclear force. The unification of all of these forces is referred to as GUT or Grand Unified Theory. Or, TOE, Theory Of Everything. Theories that attempt this unification are called superunified theories, and remain highly theoretical speculations.

BUT, there is light on the porch. There are some fascinating new theories that may well lay the basis for the GUT. Ever hear of Loop Quantum Gravity? You will. But that is just the tip of the iceberg...