

Introduction

Quantum Thoughts

It is no doubt time to update my Quantum Physics Section. It has been posted for many years now and is due for an update, based on many new discoveries by Fermilab, CERN, and a lot of researchers in general. I am rather amazed today by the number of “researchers” in the paranormal quoting explanations of paranormal activity and attributing it to quantum Mechanics, when under scrutiny, most of these “researchers” have no clue about any of the workings of quantum mechanics, or any single principle of it. While it is true that Quantum mechanics has explained many things in our world, such as radioactivity, entanglement, wave particle duality and how light works, it can warp your mind. While I believe (from years of research) that these pundits are correct in their assumptions, I think it is rather important that they understand why they are correct. In order to do this, it has occurred to me that a basic primer is needed. And while there are some excellent entry level books on the subject of the QM relationship to the paranormal (Marie D. Jone’s book “PSilence: How New Discoveries in Quantum Physics and New Science May Explain the Existence of Paranormal Phenomena”, readily comes to mind) there are not a lot of tomes dedicated to giving the average Joe a decent overview in the concepts of Quanta, and the disciplines that have grown out of it. Part of the problem I think is because to fully understand QM, you must be able to visualize its concepts, and in order to do that, you need to practice abstract perception, and non-linear thinking....

Quantum mechanics, AKA “quantum physics” or “quantum theory”, is a troublesome branch of physics providing a mathematical description for much of the dual particle-like and wave-like behavior and interactions of energy and matter. The “mavericks who practice it depart from classical mechanics, as they simply don’t work at the atomic and subatomic scales, the so-called “quantum realm”. In advanced areas of quantum research, some of these behaviors are macroscopic and only emerge during extreme conditions, such as at very low or very high energies or temperatures. The name, coined by Max Planck, derives from the observation that some physical quantities can be changed only by discrete amounts, or quanta, as multiples of the Planck constant, rather than being capable of varying continuously or by any arbitrary amount. For example, the angular momentum, or more generally the action, of an electron bound into an atom or molecule is quantized. While an unbound electron does not exhibit quantized energy levels, an electron bound in an atomic orbital has quantized values of angular momentum. In the context of quantum mechanics, the wave–particle duality of energy and matter and the uncertainty principle provide a unified view of the behavior of photons, electrons and other atomic-scale objects, something woefully lacking in classical physics.

The abstract part of Quantum mechanics is the math. Because of this, the implications are often gibberish in terms of classic physics, and as such is the cause for many classical physicists to declare it all bunk. The centerpiece of the mathematical system hinges upon the wavefunction. The wavefunction is a mathematical function providing information about the probability amplitude of position and momentum (where it is and

where and how fast it is going) of a particle. Mathematical manipulations of the wavefunction usually involve the bra-ket notation, which requires an understanding of complex numbers and linear functionals. It is not for the squeamish or weak of mind. The wavefunction treats the object like a quantum harmonic oscillator and the mathematics is very similar to that of acoustic resonance, which is probably why I took so well to its principles. Well most of them anyway. To add to its abstractness, many of the results of quantum mechanics do not have models that are easily visualized in terms of classical mechanics. It takes something of a visionary to comprehend what's going on. For instance, the ground state in the quantum mechanical model is a "non-zero energy state" that is the lowest permitted energy state of a system, rather than a more traditional system that is thought of as simply being at rest with zero kinetic energy.

Historically, quantum mechanics as a discipline was birthed in the first decade of the 20th century at around the same time as the atomic theory and the theory of light (as updated by Einstein) first became widely accepted as scientific fact. Additions to light included quantum theories of matter and electromagnetic radiation. In the mid-1920s Quantum theory was significantly reformulated away from the original concept towards the principles postulated by Werner Heisenberg, Max Born, Wolfgang Pauli and their associates, hand in hand with the acceptance of the Copenhagen interpretation of Niels Bohr. By 1930, quantum mechanics had been further unified and formalized by the work of Paul Dirac and John von Neumann, with a greater emphasis placed on measurement in quantum mechanics, the statistical nature of our knowledge of reality and philosophical speculation about the role of the observer. Quantum mechanics has since branched out into almost every aspect of 20th century physics and other disciplines such as quantum chemistry, quantum electronics, quantum optics, quantum information science and will soon show up as a new discipline called Quantum Neurology. Most of 19th century physics has been re-evaluated as the classical limit of quantum mechanics, and its more advanced developments in terms of quantum field theory and speculative quantum gravity theories, such as Loop Quantum Gravity.

The ever present or sometimes never present problem of course is Quantum objects exist in multiple states and places at the same time, requiring either an expertise in mind numbing math and or unorthodox perception to define them. Not to mention the fact that none of the principles or theories are complete, with an accompanying landscape froth with obstacles, paradoxes, unknowns, uncertainties, and indescribable particles, it is no wonder that many classical physicists throw their hands up in the air hollering "Uncle" as they flee from the room.

But it doesn't have to be that way. The struggle today among many scientists is trying to apply quantum mechanics to the task of uniting all four of the fundamental forces of the universe; Gravity, Electromagnet Fields, The Lesser Nuclear Force, and the Greater Nuclear Force. So far the former stands alone from the other three. But we are making headway. But as stated, the wavefunction is the vital key to understanding the concepts of QM. And this of course began with light.

Light's ability to behave as either a particle or a wave, depending on how and when it is observed, had been troubling scientist for many years. The Danish physicist Niels Bohr proposed that this wave-particle duality eliminated the concept of a reality separate from one's observations. In his "Copenhagen interpretation" he outlines that the act of measurement affects what is observed.

Since his proclamation, many controversial experiments have challenged this either/or scenario of light by amassing evidence that light displays both wave and particle like behavior simultaneously. Some researcher have gone as far as to say that the photon doesn't exist at all and that light appears quantized due to the way it interacts with matter. But that's just the tip of the iceberg! There are other interpretations of quantum theory that deal with the proposed measurement issue by offering the explanation that quantum objects display several behaviors as a result of their simultaneous existence in multiple or even an infinite number of parallel universes. Recently mathematician David Deutsch proved this to not only be possible but probable. But there are several more theories we need to consider.

Wave-particle duality has also been rationalized by another equally weird idea of Quantum theory called the Heisenberg Uncertainty Principle. This brainstorm of Werner Heisenberg conjured up in 1927 has recently been refined to enforce the notion of an upper limit on knowledge. Mind blowing stuff...stick with me here.

The Uncertainty Principle as the name implies, simply states that one can never know both the position and momentum of a quantum object because by measuring one, the act itself invariably changes the other.

Talk about the ultimate paradox!

An interesting historical anecdote here is the fact that Bohr defeated Einstein repeatedly in a series of thought experiments from the 1920s through 1930s using this very principle. Unfortunately, Bohr may have won the battles, but he was wrong in his assessment. We would discover in time that the source of particle duality is a condition called "entanglement".

Entanglement simply states that in the quantum world, objects are not independent if they have interacted with each other or come into being through the same process. This process causes them to become forever linked, or entangled, to such a degree that altering one will affect the other, regardless of how far apart they are. Einstein was very uncomfortable with this concept and often referred to it as "spooky action at a distance". But think about this; the concept of entanglement is far reaching, with ties to superconductivity, the construct of DNA, of life itself. In my humble opinion, and others far more advanced than I, it explains why objects have mass. Entanglement is the secret of teleporting particles across vast distances. The first teleportation of a quantum state occurred in 1998, and since then scientists have been entangling every particle they can get their hands on. They teleported photons, then atoms and ions. Now one

physicist has worked out how to do it with energy, a technique that has profound implications for the future of physics.

Masahiro Hotta at Tohoku University in Japan has developed a process of teleportation that involves making a measurement on each particle of an entangled pair of particles. Essentially, the measurement on the first particle injects quantum energy into the system. By carefully choosing the measurement to do on the second particle, it is possible to extract the original energy. This is possible because there are always quantum fluctuations in the energy of any particle. The teleportation process allows you to inject quantum energy at one point in the universe and then exploit quantum energy fluctuations to extract it from another point. Of course, the energy of the system as whole is unchanged.

Viola!

Energy conservation!!!

Ohhhmmmmmmmmmm.....

Physicists have teleported quantum information between two atoms separated by a significant distance, for the first time. Until now this feat had only been achieved between photons, and between two nearby atoms through the intermediary action of a third. According to researchers, this advance could be a significant milestone in the quest for a workable quantum computer.

Secure networks and the potential of the Quantum Computer

Entanglement is used by the IT industry on a wide scale to provide an absolutely secure means of communication. Quantum cryptographers can send "keys" to decode encrypted information using quantum particles. Attempts to intercept or "hack" those particles disturb their quantum state creating an interference that is detectable.

A quantum computer is a device for computation that makes direct use of quantum mechanical phenomena, such as superposition and entanglement, to perform operations on data. Quantum computers are different from traditional computers based on transistors. The basic principle behind quantum computation is that quantum properties can be used to represent data and perform operations on these data. A theoretical model is the quantum Turing machine, also known as the universal quantum computer. While quantum computing is still in its infancy, experiments have been carried out in which quantum computational operations were executed on a very small number of qubits (quantum bit). A few examples come to mind. In 2002, the first quantum calculation was made with a single calcium ion; three electrons were entangled in a semiconductor in 2003, and in the fall 2004, the first quantum memory component was built from a string of cesium atoms.

One of the greatest challenges, however, is controlling or removing quantum decoherence. This means you have to isolate the system from its environment as the slightest interaction with the external world would cause the system to come apart at the seams. One suggestion proposed to overcome the stability-decoherence problem is to

create a topological quantum computer with anyons, quasi-particles used as threads and relying on braid theory to form stable logic gates. Again, very heavy mind-numbing fodder. But the bottom line is if large-scale quantum computers CAN be built, they will be able to solve complex problems much faster than any current classical computers are capable of doing or will ever be capable of doing.

Particles of matter interact so easily with each other that their quantum states are preserved for a very short time, billionths of a second. Photons on the other hand, are more long lived because they are less likely to interact with each other. The drawback is they are very difficult to store because they travel at the speed of light. But in 2001 scientists were able to stop light. This led to the creation of the first quantum logic gate, with light in 2003.

The Four Horsemen of the Quantum Apocalypse

There are but four fundamental forces in our universe. These are the Strong Force, The Electromagnetic Force, The Weak Force and Gravity. The *strong force* is very strong, but very short-ranged. Its effects have a range of only four or five inches and are responsible for holding the nuclei of atoms together. It is for the most part an attractive force, but can be effectively repulsive in specific conditions such as particle polarity differentials. It is the strongest force in nature, however. The *electromagnetic force* causes electric and magnetic effects such as the repulsion between like electrical charges or the interaction of bar magnets. It is long-ranged, but much weaker than the strong force. It can be attract or repel, and acts only between pieces of matter carrying electrical charge. We call this in our line of work, EMF, short for Electromagnetic Field. The *weak force* is responsible for radioactive decay and neutrino interactions. It has a very short range and, as its name indicates, it is very weak. Quantum Mechanics explains these three completely. However, we have a problematic fourth force, Gravity, And here is where Quantum Mechanics falls apart.

The *gravitational force* is weak, but very long ranged. It is ALWAYS attractive. It acts between any two pieces of matter in the Universe because mass is its cause. Quantum physicists are working feverishly to solve this deficiency in an effort to unify the Four Horsemen of the Quantum Apocalypse. The theory Of Everything, or TOE as it is referred to, has spawned many theories that are both weird and mindboggling at the same time. Quantum Foam, in which the fabric of spacetime “bubbles” with random fluctuations comprised of various singularities including black holes, white holes and wormholes. String Theory, which states that particles and forces are created from the vibrations of tiny loops or strings, some open, some closed loops. Other concepts include space and time being discrete at the tiniest (Planck) scales, emerging from abstractions called spin networks or even super-secret doubly special relativity, which fine tunes Einstein's concept of the speed of light and adds another microcosmic small scale to the mix in an attempt to explain gravity, inflation, and dark energy. The strange truth to all of these theories is that each of them holds a significant amount of truth, which further muddies the water. Adding insult to injury, while quantum physics is generally accepted as the rules by which light and sub atomic particles are governed, many traditional physicists belief that there is a boundary or cut-off point where

Newtonian physics takes over, associating that point to the spatial location in which the pull of gravity overwhelms the other three forces.

But alas, there is a problem with that as well. Macroscopic objects can and do obey quantum rules as long as they don't entangle. Is your head hurting yet? Give it time....

But the simple truth evident here is the total understanding and control of quantum particles will create an explosion of new technologies and capabilities. The whole science of cryogenics, the super cooling of atoms to near absolute zero have created new and radical forms of matter called Bose-Einstein and fermionic condensates. With them we have created advanced lasers composed of atoms that can precisely etch an elaborate pattern on stainless steel for example, and has fueled advanced research into superconductors, and the manufacturing of incredibly strong magnets made from unlikely material such as ceramics. Research is suggesting that soon we may even be able to create superconductors that will not require super cooling!.

Additionally, due to the behavior of particles at near Planck level sizes, it is my belief that Quantum Mechanics is the most probable area in which we will find a scientific explanation for what we perceive as the paranormal. In fact, the paranormal may just be Paranormal, or the normal that we just don't know about yet.. It is from this point of reference that we are looking to find answers in our personal research at S.P.I.R.I.T. Lab.