Should creationists accept quantum mechanics?

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Quantum mechanics (QM) is one of the new ideas to emerge in physics in the 20th century. However, it has caused some consternation among Christians because of some of the counter-intuitive notions that QM seems to imply. Nevertheless, this consternation is unjustified. The evidence supports it: QM has solved problems that had baffled classical physics, and has passed numerous scientific tests. No other theory can do as much. It is also a theory of operational science, not origins science, so fighting against QM would mean unnecessarily opening up a second front in the creation-evolution 'war', and against an idea that is not antithetical to biblical creation. The history of QM—why it was developed, the problems it solved, and the motives of its founders—demonstrates that QM poses no threat to biblical creation, and even helps to show God's amazing ingenuity in biological design.

Backdrop: Classical (Newtonian) physics

Sir Isaac Newton (1642/3–1727) was probably the greatest scientist of all time—discovering the spectrum of light; the laws of motion, gravity, and cooling; as well as inventing the reflecting telescope and jointly inventing calculus. Yet he wrote more about the Bible than about science, and was a creationist.[1,2]

Newton's prowess in science was such that English poet Alexander Pope (1688–1744) wrote the famous epitaph:

> "Nature and nature's laws lay hid in night;
> God said 'Let Newton be' and all was light."

Such was his influence that Albert Michelson (1852–1931), the first American to win the Nobel Prize in physics, asserted:

> "The more important fundamental laws and facts of physical science have all been discovered, and these are so firmly established that the possibility of their ever being supplanted in consequence of new discoveries is exceedingly remote."[3]

Rather, all that remained, he thought, was more and more precise measurements. He quoted the creationist physicist William Thomson, 1st Baron Kelvin (1824–1907): "the future truths of physical science are to be looked for in the sixth place of decimals."

Now such statements mainly produce mirth. Even Kelvin himself recognized two 'dark clouds' hanging over classical physics, which known theories could not explain:

1. The experiment of Michelson and Morley (1838–1923) that showed effectively no difference in the measured speed of light regardless of direction—to be solved by Einstein's theory of special relativity, which is outside the scope of this article. Suffice it to say, Einstein made it clear that he deduced many of his ideas[4] from the electromagnetism equations of James Clerk Maxwell, the great creationist classical physicist.[5] Furthermore, Relativity hasn't the slightest thing to do with moral relativism: Relativity replaces absolute time and space with another absolute: the speed of light in a vacuum. To underscore this point, Einstein himself preferred the term 'Invariance Theory'.
2. Black body radiation, which, as will be shown, was one of the mysteries to be solved by quantum mechanics.

Three clouds

Actually, there were *three* main problems that stumped Newtonian 'classical' physics. Quantum mechanics solved them: blackbody radiation, the photoelectric effect, and atomic structure. Therefore, QM is totally unlike Darwinian evolution: QM was driven by unsolved problems and supported by the evidence, and not with any hidden agenda against a creator. Furthermore, most of the pioneers were reluctant to abandon classical physics.

It is important to recognize that the Creation/Fall/Flood is a historical framework taught by the Bible; classical physics is at best just a model to explain how God upholds His creation, not a direct teaching of Scripture. So disagreements with classical physics are in no way like the contradictions of biblical history by uniformitarian geologists and evolutionary biologists.

We also should notice how many of the discoveries that led to QM were rewarded with a Nobel Prize for Physics. By contrast, one gripe of evolutionists is the lack of an award for evolutionary biology;[6] Nobel Prizes are awarded only for practical, testable science.[7]

Photo courtesy of Wikipedia

Figure 1. The spectrum in a rainbow

1. Blackbody radiation

A blackbody is an idealized perfect absorber of all radiation and, as a consequence, is also a perfect emitter. The best approximation to this is a material called super-black, with tiny cavities, actually modelled on the wing rims of certain butterflies.[8]

Classical physics predicted that the blackbody would be a 'vibrator' with certain modes, which had different frequencies. And it also predicted that every mode would have the same energy, proportional to temperature (called the *Equipartition Theorem*). The problem is that there would be more modes at short wavelengths, thus high frequencies, so these modes would have most of the energy. Classical physics led to the *Rayleigh–Jeans Law,*[9] which stated that the energy emitted at a given frequency was proportional to the fourth power of that frequency.

This worked well for low frequencies, but predicted that the radiation would be more and more intense at higher frequencies, i.e. the ultraviolet region of the spectrum (figure 1) and beyond. In fact, it would tend towards infinite energy—clearly this is impossible, hence the term 'ultraviolet catastrophe'.

Max Planck (1858–1947) (figure 2) solved this problem. Instead of the classical idea, that any mode of oscillation could have any energy, he proposed that they could have only discrete amounts—packets of energy proportional to the frequency. That is, $E = h\nu$, where E is energy, ν (Greek letter *nu*) is frequency, and h is now called Planck's constant.[10] This meant that a mode could not be activated unless it had this minimum amount of energy. The new Planck's Law matched the observations extremely well at both high and low frequencies. He won the 1919 physics Nobel "in recognition of the services he rendered to the advancement of Physics by his discovery of energy quanta".[11]

Interestingly, Planck had no thought that he had solved a catastrophe, just that his idea fitted the data well. Rather, he rightly realized that the equipartition theorem was not applicable.[12] Furthermore, he was sympathetic to Christianity and critical of atheism.[13]

2. Photo-electric effect

We all know about solar cells now, but over a century ago, the photo-electric effect behind them was a mystery. It was discovered that light could knock electrons out of a material, but the electron energy had nothing to do with intensity of the light; rather it depended on the frequency. Furthermore, light below a certain threshold frequency had no effect. Very curious: bright red light (low-frequency) would not work, while faint ultraviolet light (high-frequency) would, even though the energy of the red light was far greater in such cases.

Einstein solved this by proposing that light itself was quantized: came in packets of energy:

> "According to the assumption to be contemplated here, when a light ray is spreading from a point, the energy is not distributed continuously over ever-increasing spaces, but consists of a finite number of *energy quanta* that are localized in points in space, move without dividing, and can be absorbed or generated only as a whole."[14]

Only if the energy packet were greater than the binding energy of the electron would it be emitted. The resulting electron energy would be the difference of the light packet energy and binding energy. So while Planck proposed quantized *oscillators*, Einstein proposed that *electromagnetic radiation* was quantized.

Figure 2. Max Planck (1858–1947)

It was explicitly for *this* discovery, *not* relativity, that Einstein was awarded the 1921 Nobel Prize for Physics "for his services to Theoretical Physics, and especially for his discovery of the law of the photoelectric effect."[15]

Einstein called this *Lichtquant* or light quantum, but the American physical

Stimulated emission and lasers

In 1917, Einstein realized that a photon with the same energy as the energy difference could increase the probability of this transition.[18] Such stimulated emission would produce another photon with the same energy, phase, polarization and direction of travel as the incident photon. This was the first paper to show that atomic transitions would obey simple statistical laws, so was very important for the development of QM. On the practical side, it is immensely valuable, because it is also the basis for masers and lasers. These words were acronyms for Microwave/Light Amplification by Stimulated Emission of Radiation. As a result:

> "The Nobel Prize in Physics 1964 was divided, one half awarded to Charles Hard Townes, the other half jointly to Nicolay Gennadiyevich Basov and Aleksandr Mikhailovich Prokhorov 'for fundamental work in the field of quantum electronics, which has led to the construction of oscillators and amplifiers based on the maser-laser principle.'"[19]

My own green laser pointer relies on an additional QM effect called "second harmonic generation" or "frequency doubling". Here, two photons are absorbed in certain materials with non-linear optics, and a photon with the combined energy is emitted. In this case, an 808 nm infrared source pumps an infrared laser with a lower energy of 1064 nm, and this frequency is doubled to produce a green laser beam of 532 nm.

chemist Gilbert Newton Lewis (1875–1946) coined the term *photon*,[16] which stuck.

Ironically, like Planck, Einstein didn't conceive himself as anything more than a classicist. He later vocally opposed the prevailing quantum mechanical interpretations by the Dane Niels Bohr (1885–1962), now called the Copenhagen Interpretation.

3. Atoms

Newton's discoveries in the spectrum of light presumed that colour was continuous. But when the spectra of individual atoms were measured, they emitted light at discrete frequencies (or absorbed it—dark lines in a 'white light' spectrum).

Furthermore, the New Zealand physicist Ernst Rutherford (1871–1937) showed that most of the mass of the atoms was concentrated in a tiny positively charged nucleus, and proposed that electrons orbited like the planets around the sun. The Rutherford model is iconic—it is what most people imagine when they think of atoms, and is even used in the logo of the United States Atomic Energy Commission and the flag of the International Atomic Energy Agency. Rutherford inexplicably missed out on the Nobel Prize for Physics—instead, the Nobel Prize committee magically transformed him into a chemist, awarding him the *Chemistry Prize* instead, "for his investigations into the disintegration of the elements, and the chemistry of radioactive substances."[17]

However, classical physics predicted that orbiting charged particles like electrons would lose energy to electromagnetic radiation. So their orbits would decay.

To solve this problem, Bohr proposed, in 1913, that electrons could move only in discrete orbits, and that these orbits were stable indefinitely. Energy was gained or lost only when the electrons changed orbits, absorbing or emitting electromagnetic radiation of frequency $\nu = E/h$, where E is the energy difference between the states. For electrons in higher energy or 'excited' states, this transition would mostly be spontaneous (but see box, left).

Bohr's model strictly applied only to one-electron atoms such as H, He^{+}, and Li^{2+}. But he extended it to multi-electron atoms: he proposed that these discrete energy levels could hold only a certain number of electrons—electron *shells*. This explains the relative inertness of the 'noble' gases: they *already* have full shells, so no need to chemically react with another atom to achieve them. It also explains the highly reactive alkali metals: they have one surplus electron, so can lose it relatively easily to achieve the all-full shell configuration; and the halogens are one electron short, so vigorously try to acquire that one remaining electron from another atom. An illustration of both is the alkali metal halide sodium chloride.

High-school chemistry typically doesn't go past the Bohr model approach; university chemistry tends to go deeper into more modern quantum mechanics (atomic and molecular orbital theory), of which the Bohr model was a pioneering attempt. Bohr won the physics Nobel in 1922 "for his services in the investigation of the structure of atoms and of the radiation emanating from them."[20]

Like Heisenberg and Einstein, Bohr was not happy with aspects of quantum mechanics. In Bohr's case, for a long time, he was a determined opponent of the existence of photons, trying to preserve continuity in electromagnetic radiation. Bohr also introduced the 'correspondence principle': that the new quantum theory must approach classical physics in its predictions when the quantum numbers are large (similarly, relativity theory collapses to ordinary Newtonian physics with velocities that are much smaller than that of light).

Wave-particle duality

The French historian-turned-physicist Louis-Victor-Pierre-Raymond, 7th duc de Broglie (1892–1987), provided another essential concept of quantum mechanics. Just as the energy of vibrators and electromagnetic radiation was quantized into discrete packets with particle-like properties, de Broglie proposed that all moving particles had an associated wave-like nature. The wavelength was inversely proportional to momentum, again using Planck's Constant: λ = *h/p*, where λ (Greek letter lambda) is wavelength, and p = momentum. This was the subject of his Ph.D. thesis in 1924:[21] his own examiners didn't know what to think, so they asked Einstein. Einstein was most impressed, so de Broglie was awarded his doctorate. Only five years later, he was awarded the Physics Nobel "for his discovery of the wave nature of electrons."[22]

It is notable that this prize was awarded before the wave nature of electrons was proven. This happened beyond reasonable doubt when Clinton Joseph Davisson (1881–1958) and George Paget Thomson (1892–1975) were awarded the 1937 Physics Nobel "for their experimental discovery [made independently of each other] of the diffraction of electrons by crystals."[23] Thomson was the son of J.J. Thomson (1856–1940), who discovered the electron itself. For example, electrons can produce the classic 'double slit' interference pattern of alternating 'light' and 'dark' bands. This pattern is produced even when only one electron goes through a slit at a time.

The discovery of matter waves was instrumental for electron microscopes, which allow smaller objects to be seen than with optical microscopes, because the electrons have a smaller wavelength than visible light. The same principle is used for probing atomic arrangements with neutron diffraction—neutrons are almost 2,000 times more massive than electrons, so normally have much more momentum, thus an even smaller wavelength.

Thus de Broglie showed that at a foundational level, both radiation and matter behave as both waves and particles. Writing almost half a century later, he recalled:

> "When I conceived the first basic ideas of wave mechanics in 1923–24, I was guided by the aim to perform a real physical synthesis, valid for all particles, of the coexistence of the wave and of the corpuscular aspects that Einstein had introduced for photons in his theory of light quanta in 1905."[24]

But this unified theory did not permit wave and particle qualities to be observed at the same time; it was always one or the other.

Mathematical formulations

In 1925, Werner Heisenberg (1901–1976) formulated a mathematical model to explain the intensity of hydrogen spectral lines. He was then the assistant of Max Born (1882–1970), who recognized that matrix algebra would best explain Heisenberg's work. Heisenberg was recognized with the 1932 physics Nobel "for the creation of quantum mechanics, the application of which has, *inter alia*, led to the discovery of the allotropic forms of hydrogen".[25]

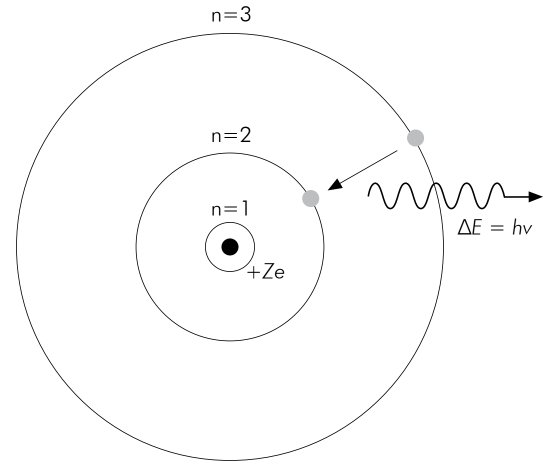

Photo courtesy of Wikipedia

Figure 3. Rutherford–Bohr model of the hydrogen atom

Next year, Erwin Schrödinger (1887–1961) developed de Broglie's ideas of matter waves into the eponymous *Schrödinger equation*. This describes a physical system in terms of the *wavefunction* (symbol ψ or Ψ–lower case and capital *psi*), and how it changes over time. For a system not changing over time, 'standing wave' solutions allow the calculation of the possible allowable stationary states and their energies. This brilliantly predicted the energy levels of the hydrogen atom (figure 3). Later these stationary states were called atomic orbitals; applied to molecules, they are molecular orbitals, without which much of modern chemistry would be impossible. Other applications of this equation included the calculation of molecular vibrational and rotational states.

Schrödinger's treatment, as he showed, was equivalent to Heisenberg's: the stationary states correspond to eigenstates, and the energies to eigenvalues (*eigen* is the German word for 'own' in the sense of 'peculiar' or 'characteristic'). The overall wavefunction could be considered as a superposition of the eigenstates. As Einstein warmly embraced de Broglie's idea, he did the same to Schrödinger's, as a more 'physical' theory than Heisenberg's matrices. In 1930, Paul Dirac (1902–1984) combined the two into a single mathematical treatment. Schrödinger and Dirac shared the 1933 Nobel Prize for physics "for the discovery of new productive forms of atomic theory."[26]

Schrödinger was another reluctant convert to QM—he hoped that his wave equation would *avoid* discontinuous quantum jumps. But he was due to be disappointed: in 1926, Max Born showed that Ψ didn't have a physical nature; rather, the *square of its magnitude* $|\Psi|^2$ *would equal the probability of finding the particle localized in that place*. For political reasons, with the developing turmoil of the rise of National Socialism in his country, Born wasn't awarded the Nobel Prize for physics until 1954, a half share "for his fundamental research in quantum mechanics, especially for his statistical interpretation of the wavefunction”.[27]

Weird things

Here is where we find the root of much opposition: the apparently strange things that quantum mechanics predicts.

Uncertainty principle

Heisenberg recognized a fundamental limit to what could be measured. E.g. try to measure the position and momentum of an electron as finely as possible by shining a light photon on it. To fine-tune the position better, we need a small wavelength. But as de Broglie showed, the shorter the wavelength, the larger the momentum, thus the more that can be transferred to the electron. So the electron’s momentum cannot be known precisely. And if we reduce the momentum of the photon to avoid disturbing the electron too much, the wavelength increases, so its position becomes less certain. It is smeared out in space. Thus, as Heisenberg said: “It is impossible to determine accurately *both* the position and the direction and speed of a particle *at the same instant*.”[28] To be precise, the uncertainty in position and momentum is related to Planck’s Constant $\Delta x \Delta p \geq h/4\pi$. The same applies to energy and time: $\Delta E \Delta t \geq h/4\pi$.

Actually, there was a precedent for this in the remarkably productive mind of Einstein: he had recognized that there would be a residual energy even at absolute zero, which he called *Nullpunktsenergie*,[29] or in English *zero-point energy*. It is easily explained in terms of the uncertainty principle: if there were a zero-energy state in some crystal lattice with fixed atomic positions, it would entail that the atoms’ positions and momenta could be known with total precision. To avoid this, there must be some residual energy.

This is actually proved by the inability to solidify helium no matter how cold, except under very high pressures (25 atmospheres): the zero-point energy would shake any solid lattice apart.

But despite his contribution, Einstein detested the uncertainty principle. In the years around 1930, he debated Bohr on various ways around it. These two admired each other greatly, but most physicists thought that Bohr had the better of the arguments—in one famous riposte, he used Einstein’s own theory of general relativity to defeat an ingenious thought experiment.

Interpretations of QM

This is where many of the problems lie. Probably the most common view is called the Copenhagen Interpretation, after Bohr’s place of research. It holds that the wavefunction exists as a superposition of all possible probabilistic states. But after a measurement or observation, we now know where something is with 100% probability, so the wavefunction is ‘collapsed’ to just one of those states.

Some New Agers have imposed a mystical, relativistic view of QM, asserting that reality is not objective but depends on conscious observers. Both Einstein and Schrödinger didn’t like the mysticism of a supposed ‘observer collapses the wavefunction’. Einstein argued that a barrel of unstable explosive would contain a superposition of exploded and unexploded states. Schrödinger applied this idea to one of the most famous illustrations of QM, now called the *Schrödinger’s Cat Paradox*. But this was a thought experiment intended as a *reductio ad absurdum* of what he thought was a ridiculous type of interpretation of QM, since he rightly thought that the law of non-contradiction trumped the interpretation:[30]

> “One can even set up quite ridiculous cases. A cat is penned up in a steel chamber, along with the following device (which must be secured against direct interference by the cat): in a Geiger counter, there is a tiny bit of radioactive substance, so small that perhaps in the course of the hour, one of the atoms decays, but also, with equal probability, perhaps none; if it happens, the counter tube discharges, and through a relay releases a hammer that shatters a small flask of hydrocyanic acid. If one has left this entire system to itself for an hour, one would say that the cat still lives if meanwhile no atom has decayed. The psi-function of the entire system would express this by having in it the living and dead cat (pardon the expression) mixed or smeared out in equal parts.
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> “It is typical of these cases that an indeterminacy originally restricted to the atomic domain becomes transformed into macroscopic indeterminacy, which can then be resolved by direct observation. That prevents us from so naively accepting as valid a ‘blurred model’ for representing reality. In itself, it would not embody anything unclear or contradictory. There is a difference between a shaky or out-of-focus photograph and a snapshot of clouds and fog banks.”

However, Bohr never claimed any ‘collapse requires consciousness’ view; all that was required for an ‘observation’ was a thermodynamically irreversible change. While a watched pot supposedly never boils, I found no difference in spectra whether I watched them or just set up the experiment to run. Also, the nuclear fusion reactions in the sun’s core work by QM but there is no conscious mind watching, unless you count spiritual beings, which Copenhagen generally does not. From a biblical standpoint, there were plenty of things happening uniformly before God created man on Day 6 to observe any of them.

Thus some creationist (and non-creationist) physicists accept QM but propose a more realist interpretation just as Einstein and Schrödinger advocated. But many of the creationist critics of QM confuse QM with *interpretations* of QM.

E.g. physicist Dr Russell Humphreys explains (personal communication):

> "In contrast with the Copenhagen interpretation, the Causal interpretation says that all particles have a definite location and speed at all times, even if we cannot measure both those numbers precisely at the same time. It further says that quantum-mechanical waves are real, and that they can influence the motion of the particles. Like a motorboat moving on a lake, the motion of a particle generates waves in the space nearby it, and those waves influence the path of the particle through space.
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> "For example, in the famous two-slit experiments (described in most quantum mechanics textbooks), the Causal interpretation says that a particle approaching the slits only goes through one of them, but that the waves moving with the particle go through both slits. On the far side of the slits, the waves interfere with each other, setting up a pattern of peaks and troughs that guide the particle as it travels. The precise path it travels depends on precisely where it passed through the slit. This view of what is observed in experiments is far more straightforward than what the Copenhagen interpretation claims.
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> "The Causal interpretation, held by a minority of well-known physicists since the 1920s, has become fairly well-developed in recent years. One of the best presentations of it for physicists is *The Quantum Theory of Motion: An Account of the de Broglie–Bohm Causal Interpretion of Quantum Mechanics,* by Peter R. Holland.[31] Unfortunately, I know of no exposition of the Causal interpretation for laymen."

But many of the creationist critics of QM confuse QM with *interpretations* of QM.

Entanglement

Another strange effect is 'entanglement': two particles interact and thus share the same quantum state until a measurement is made. But we do know something about them, e.g. that their 'spins' must be opposite; just that we don't know which one has which spin. Then the particles go their separate ways. Then we measure one of them, and find that it has, say, an anticlockwise spin. This means that the other one must *instantly* adopt clockwise spin—and so it will prove when it's measured at *any* later time, as long as the entanglement is not otherwise disrupted. Both Einstein and Schrödinger disliked the apparent implication that this correlation would travel much faster than light. But many experiments are consistent with this implication, for example one with entangled photons:

> "The results also set a lower bound on the 'speed of quantum information' to $2/3 \times 10^7$ and $3/2 \times 10^4$ times the speed of light in the Geneva and the background radiation reference frames, respectively."[32]

To put this into perspective, Newton's conception of gravitation was criticized at the time for postulating an 'occult' action-at-a-distance force which he thought acted instantly (under General Relativity, the force of gravity moves at the speed of light). There is no reason why God's upholding of His creation (cf. Colossians 1:15) should be limited by the speed of light, especially as God is the creator of time itself.

More evidence

I could not have worked in my own specialist area of spectroscopy unless molecules had quantized energy states, especially in vibrational energy in my case, but electronic states and rotational states as well.

Superconductors and superfluids

Other interesting evidences include superconductors, which I have also researched,[33] and superfluids. These are substances with exactly zero resistivity and zero viscosity, respectively.

These are rare examples of quantum behaviour on the macro level. They are related to yet another prediction by Einstein, this time with Satyendra Nath Bose (1894–1974): they realized that at very low temperatures, the wavefunctions of identical particles could overlap to form a single quantum state, now called a *Bose–Einstein Condensate*.

This easily explains why it is possible to have zero resistance and viscosity. A current of electrons or fluid usually loses energy to the surrounding materials, but if they are in one quantum state, any possible energy loss would be quantized, thus could not occur below this threshold. Superfluids also exhibit quantized vortices.

Woodward–Hoffmann rules for electrocyclic reactions

One class of organic reactions is *electrocyclic*, where a conjugated unsaturated 'straight' chain hydrocarbon closes into a ring, or the reverse. To do this, there must be some rotation—either the two ends must rotate both clockwise / both anticlockwise (*conrotatory*); or one clockwise and the other anticlockwise (*disrotatory*). Whether it's conrotatory or disrotatory turns out to be completely determined. Robert Burns Woodward (1917–1979) and Roald Hoffmann (1937–) worked out the eponymous rules, based on the conservation of symmetry of the molecular orbitals, which no known classical model could predict.

In particular, the lobes of the molecular orbital can form a bond only if the wavefunction has the same sign (positive or negative), and this can be achieved only by rotation in one of the two possible types (*conrotatory* or *disrotatory*). Furthermore, a photochemical reaction turns out to have the opposite symmetry, also explained because the photon excites an electron into another orbital with a different symmetry.

Hoffmann shared the 1981 Nobel with Kenichi Fukui (1918–1998) "for their theories, developed independently, concerning the course of chemical reactions." Woodward had died before he could be awarded his second Nobel Chemistry Prize.

Designs in nature using QM

Another good reason to support QM is that it is proving to be an ally of the Creation model. Some time ago I wrote on how our sense of smell works in accordance with vibrational spectroscopy and quantum mechanical tunnelling:

> "Luca Turin, a biophysicist at University College, London, proposed a mechanism [34,35] where an electron tunnels from a donor site to an acceptor site on the receptor molecule, causing it to release the g-protein. Tunnelling requires both the starting and finishing points to have the same energy, but Turin believes that the donor site has a higher energy than the receptor. The energy difference is precisely that needed to excite the odour molecule into a higher vibrational quantum state. Therefore when the odour molecule lands, it can absorb the right amount of the electron's energy, enabling tunnelling through its orbitals. This means the smell receptors actually detect the energy of vibrational quantum transitions in the odour molecules, as first proposed by G.M. Dyson in 1937."[36]

More recent support comes from studies in bird navigation. For some time now, it has been known that birds and many other creatures use the earth's magnetic field for navigation.[37] But in European robins, red and yellow light somehow disorients their magnetic sense. So some researchers proposed that light causes one of the eye proteins to emit a pair of 'entangled' electrons with opposite spins. Again, we don't know which is which until a measurement occurs, and here this 'measurement' is caused by some difference in the earth's magnetic field. Thus the other electron must instantly adopt the opposite spin, which the bird detects and somehow computes the information about the magnetism. The birds are disoriented by weak oscillating magnetic field, which could not affect a macro-magnet like a magnetite crystal, but would disrupt an entangled pair.[38]

A recent paper paid its usual vacuous homage to evolution:

> "In artificial systems, quantum superposition and entanglement typically decay rapidly unless cryogenic temperatures are used. Could life have evolved to exploit such delicate phenomena? Certain migratory birds have the ability to sense very subtle variations in Earth's magnetic field. Here we apply quantum information theory and the widely accepted 'radical pair' model to analyze recent experimental observations of the avian compass. We find that superposition and entanglement are sustained in this living system for at least tens of microseconds, exceeding the durations achieved in the best comparable man-made molecular systems. This conclusion is starkly at variance with the view that life is too 'warm and wet' for such quantum phenomena to endure."[39]

Of course, this is more evidence of a *Designer* whose techniques far exceed the best that man can do—in this case, maintaining quantum entanglement far longer than we can![40]

Conclusion

Quantum mechanics really works, and has been strongly supported by experiment. The history and practice of QM show no hidden motivation to attack a biblical worldview, in contrast to uniformitarian geology and evolutionary biology. Any proposed replacement theory needs to explain at least all the observations that QM does. This is not a specifically creationist project.

It seems wise for creationists to adopt the prevailing theories of operational science unless there are good observational reasons not to. Otherwise it could give the impression that we are anti-establishment for its own sake, rather than *pro-Bible* and opposing the establishment only when it contradicts biblical history. Fighting on two fronts has usually been a losing battle strategy. Rather, as previously with relativity, it makes more sense to co-opt it as an ally of creation, as with some of the design features in nature.

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