Essay 11. Quantum Spin by David Ash © 2024

"A future theory must bring about a deep unification of foundations." Wolfgang Pauli

Precis: In previous essays published in my book ***Was Einstein Right?*** I questioned Heisenberg's principle of uncertainty. Despite my reservations about his uncertainty principle I have great respect for Werner Heisenberg and his colleague Wolfgang Pauli as brilliant mathematical physicists. In this essay I show how their contributions to the discovery of quantum spin led to problems in understanding quantum reality. I then go on to show how the vortex of energy provides a straightforward account for quantum spin, which leads to simple solutions to the problems they encountered. I then show how the image of quantum spin that emerged in the vortex theory, led to an account for mass, inertia, space, electric charge and a way to meld the quantum and relativity theories.

A review of the history of quantum spin can help us to appreciate the importance of the vortex theory as a way to visualise quantum reality. The difficulty that the pioneers of quantum mechanics had in visualizing their mathematical discoveries, especially in regard to quantum spin, caused them to abandon realism and to disparage attempts to provide visual images of quantum reality as naïve. The graphic image of quantum spin in the vortex theory is a major achievement as it restores realism to quantum theory and its visible success in accounting for the universe at large suggests it is not naïve.

A major objective of my work is to establish visual images of the quantum world of physics. For this purpose I approached the subject through art rather than mathematics. This approach is valid insofar as it enabled me to provide a way of visualising of quantum reality, which in near on a century, mathematicians failed to achieve.

When, as a sixteen year old I discovered the image of vortices of energy in yogic philosophy, as an account for fundamental particles of matter, I realised it would be possible to obtain a realistic visual images of the quantum world. Nearly sixty years later, when I walked into an exhibition of paintings by the American artist Shane Guffogg, in the *Vanities Gallery,* Rue Biscornet in Paris, I was confronted by a display of pictures that closely depicted the vortex of energy. Immediately I invited Shane to include his cosmic art in my new book, *Was Einstein Right?* I realised his work offered an opportunity, not only to depict the vortex of energy, but to present my book as a fusion of art and science. Shane commented that other quantum physicists had said that his art depicted their equations. Providing a visual depiction of quantum reality in artform is important if the world of the quantum is to be accessed by everyone, not just a few scientists with advanced skills in mathematics.

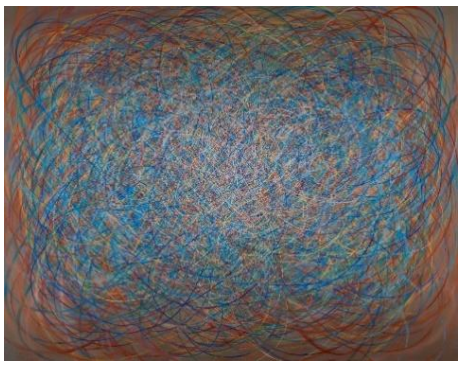


Fig. 1. Only through time time is conquered by Shane Guffogg

Essay: There was a vortex theory for the atom in England toward the end of the nineteenth century but it didn't lead to the concept of quantum spin in modern physics. That came from the study of the spectral lines that led to the demise of the vortex atom theory.

When atoms are bombarded with light they emit light in frequency bands known as *spectral lines.* The pattern of lines, unique to each atom, break up into finer lines, when exposed to a magnetic field. This was discovered in the 19th century by Michael Faraday but it required more advanced equipment of the 20th century to study them properly. However, the fine lines proved to be a challenge to explain. Niels Bohr, who had explained spectral lines by applying Einstein's quantum theory to electron orbits in the atom, gave the task of working out a formula for these *fine spectral lines* to a brilliant young mathematician in his team, Wolfgang Pauli. When Pauli stalled his professor and mentor, Arnold Sommerfeld, who was an expert of spectral lines, handed the task to another brilliant young mathematician, Werner Heisenberg, who was then only nineteen. Heisenberg made

rapid progress when, in a flash of genius, he rewrote one of Sommerfeld's equations using half figures. From that momentous insight the concept of the half quantum entered quantum mechanics.

It had been assumed that the quantum was the most fundamental particle of energy therefore it must be indivisible. But just as the indivisible atom had suffered the ignominy of being split it seemed the quantum had to suffer the same fate. Sommerfeld, Bohr and Pauli were stunned when Heisenberg's equation, incorporating half a quantum was applied to the fine spectral lines. It worked perfectly. Heisenberg was able to write back to Pauli, *"Success sanctifies the means."*

Fig. 2. Werner Heisenberg

Meanwhile, Pauli had come up with his own stroke of genius. Bohr had applied three quantum numbers to electrons in atoms. These represented the dimensions of freedom in which electrons can move but Pauli, through careful examination of scientific data, realised there had to be a fourth quantum number. This worked when relativity theory was applied to the speeds of electrons in atoms. To begin with Bohr thought he was crazy but after a week of ruminations he realised Pauli was onto something big. Pauli's four quantum numbers worked to explain the periodic table of the elements but only if an exclusion principle was applied that no two electrons in an atom could have the same four quantum numbers. This came to be known as the *Pauli exclusion principle* for which he received the 1945 Nobel Prize in physics.

Fig 3. Wolfgang Pauli

However, people were having a problem visualizing the fourth quantum number. They could imagine the three quantum numbers as the freedom for electrons to move in space. If we are free to move in three dimensions of space, up or down, left or right, backwards or forwards why would electrons be different. But Pauli's fourth quantum number didn't represent that. Then a twenty year old German American, Ralph Kronig spotted something Pauli had missed. Pauli's number had the properties of spin with the annoying half quantum. When Kronig assigned for every electron a spin value of half either plus or minus it worked in experimental physics to explain every known atom in the periodic table of the elements. In time it came to be accepted and known as *quantum spin.* Despite a lack of understanding what the enigmatic half spin of an electron could be, physicists imagined Pauli's quantum spin number must represent a spinning electron.

Fig. 4. Ralph Kronig

Recognition didn't come to Kronig. He never published his findings because Bohr frowned on it. Bohr had said, to Pauli his theory of a fourth quantum number was crazy so when Kronig came along with Heisenberg's half integer applied to it and said it was spin, that set Bohr in a spin and taking it that the square of craziness equals total insanity he discouraged Kronig from publishing his findings. However, nine months later two Dutch physicists George Uhlenbeck and Samuel Goudsmit, proved Kronig was right in his concept of quantum spin but they took the credit for it as they were the first to publish.

Fig. 5. George Uhlenbeck and Samuel Goudsmit

However, in their publication they took Pauli's maddening fourth quantum number to a new level of insanity. They made it clear that quantum spin did not represent the top-like spin of an electron. It had to be an entirely different sort of spin altogether, which nobody could visualise. On the strength of this dilemma Pauli came on strong to Bohr demanding that visual images should be dropped from the burgeoning Copenhagen interpretation of quantum reality as they were misleading and unhelpful.

Fig. 6. Niels Bohr

With the agreement of Heisenberg, who was battling to visualise half a quantum, attempts at visual imagery were dropped and dubbed *naïve realism.* Despite the protests of Albert Einstein, common sense and realism disappeared from the quantum theory he had instigated. In the words of Arthur Miller from his book *137*: [1]

> "Spin was undeniably a property of an electron but it was entirely impossible to visualize it in a way consistent with relativity theory. Scientists had to accept that the fourth quantum number had no accompanying visual image. It was time for atomic physics to move on from trying to visualise everything in images relating to the world in which we live."

The problem with this approach is that whereas scientists may be satisfied with mathematical equations, the rest of us depend on visual imagery for our understanding of the Universe. The architects of quantum mechanics may have dispatched realism from quantum physics because they found the realistic images available to them were counterproductive but I think it was a bit naïve of them to dismiss realism altogether, just because they couldn't come up with realistic images of what they were realising in their equations. They were the impetuous boys of the *Knabenphysik,* 'the boys physics'. Had they been more mature they might have made allowance for others in future generations to solve the visualisation problem, rather than dismiss the possibility of visual imaging of quantum reality. A generation later I discovered a solution to the problem of visualising quantum spin in the visualisation of the vortex of prana by mystics in the ancient tradition of yoga.

In fairness to Pauli he did write a letter to Bohr saying, *"…Once the systems of concepts are settled then will visualizability be regained."* [2] He who had dispelled realism predicted its return to quantum physics once the mathematics was settled. It has been a long time coming especially considering the book that contained the visual image of quantum spin has never been out of print since 1905.[3] In part this is because professional physicists have assumed the visualization of quantum reality could never be achieved- it has become a cliché to say that nobody understands quantum mechanics but in part it could be due to the contempt many scientists an academics hold for mystics. In *Hidden Journey*[3] Andrew Harvey quoted an Oxford academic as saying, *"Only scientific criteria for truth are valuable and mystics are pathological cases."* [4]

I achieved the unachievable because my father, who introduced me to physics, was open to mysticism, which is not anathema in science because, as Arnold Sommerfeld said, *"Science emerged from mysticism and has never completely separated itself."* [5] As a teenager I was as fascinated by the mystical traditions as I was by physics and I was profoundly influenced by yogic philosophy so I was able to connect the dots between yoga and physics. When I went on to become a physics teacher I realised the importance of pictures, analogies and explanations as indispensable tools in science education. They are as needed in the appreciation of quantum physics as in any other subject. I am passionate to restore realism to quantum physics because without visual images people at large have no hope of appreciating quantum reality.

Fig. 7. Arnold Sommerfeld

The vortex theory, as an attempt to address the visualizability issue in quantum mechanics, could be viewed as naïve realism but as a teacher of physics I appreciate that naivety in art has value in teaching because the simpler the image the more effective it can be in conveying its subject matter. The theory I have developed is not formal, precise or correct on every point and the images and analogies in it are only crude illustrations of the points they are intended to put across. Nonetheless, the theory of the quantum vortex does provide a way to appreciate the half quantum and its relationship to quantum spin.

The term *quantum* applies to energy not matter therefore terms such as quantum spin and quantum numbers should apply to the quantum of energy forming a particle of matter (or antimatter) not to the particle it forms. For example, the fourth quantum number, representing quantum spin, should apply to the vortex spin of energy forming an electron not to the subsequent spin or any other movement of the electron. That simple logic explains the discovery of George Uhlenbeck and Samuel Goudsmit that quantum spin does not apply to the top-like spin of an electron. Quantum spin can only apply to the three dimensional spin of energy forming an electron, not to the rotational spin of the electron responsible for its natural magnetism (magnetic moment).

Because energy has no mass the laws of angular momentum would not apply to the energy spin that forms an electron. The Uhlenbeck - Goudsmit principle would explain why the value of quantum spin is identical for every electron regardless of its momentum. Angular momentum would apply to the subsequent top-like spin of the electron that sets up its magnetic moment.

If the fourth quantum number applies to the spin of energy forming the electron and not the spin of the electron itself then the other three quantum numbers could apply to the three dimensional freedom of movement of energy in the vortex forming the electron rather than to the freedom of the electron to move. The freedom of movement of energy to spin in a quantum vortex would set up a spherical ball vortex much as the freedom of movement for wool to wind in three dimensions sets up a ball of wool. When wool winds on or off the ball, it is a vortex and the spherical spin of wool onto or off the ball would cause the ball to grow or shrink. The simultaneous motion in three dimensions of energy, in a spherical quantum vortex, causing it to grow or to shrink could constitute the fourth quantum number identified by Wolfgang Pauli; it could be the fourth dimension of space, the dimension of bigness or smallness.

A vortex is a three dimensional spiral. There are a number of different types of vortex. There is the conical vortex exemplified by water going down a plug hole or air circulating in a weather system and there is the toroid vortex exemplified by a smoke ring. But to neither of these would the three quantum numbers apply as the three quantum numbers apply to an even distribution of the three dimensions of space depicted by a sphere. The only vortex of energy to which the three quantum numbers of Niels Bohr could apply would be a spherical ball vortex. exemplified by a ball of wool. The degrees of freedom for energy to spin could only result in the formation of a ball vortex not a conical or toroidal vortex. Toroidal vortex theories for subatomic particles are incorrect.

Fig. 8. Toroid vortex smoke ring

As energy flows in or out of a ball vortex, in perfect symmetry in three dimensions, it would form a dynamic system of spheres that are either expanding or contracting. The vortex of energy, as a system of growing or shrinking spheres moving simultaneously in the three dimensions of space, could give rise to a fourth dimension of space which is not separate from the other three dimensions but would be a combination of all three. The spin of energy in the vortex could thus account for the fourth quantum number proposed by Wolfgang Pauli and Kronig's discovery of quantum spin and his discovery of plus and minus values attributed to quantum spin. These would represent the opposite directions of spin, into or out of the vortex.

In the vortex theory the three quantum numbers represent the three dimensional spin of energy in a ball vortex. The fourth quantum number, representing the opposite direction of spin into or out of the vortex, is considered to be responsible for the opposite sign of charge in subatomic particles. In the vortex theory the spherical quantum spin of energy is also considered to set up the inertial mass of subatomic particles. Just a gyroscopic spin sets up resistance to movement out of the plane of spin so the spin of energy on infinite planes, forming a ball vortex, would set up resistance to movement of the vortex in any direction. This would account for the static inertia associated with mass. In the *Character of Physical Law,* Richard Feynman said "*The laws of inertia have no known origin."* [5] The vortex theory provides a simple and straightforward account for the laws of inertia.

Fig. 9. Richard Feynman

The Higgs boson theory for mass is not recognised in the vortex theory as it depends on the Heisenberg uncertainty principle, published in 1927, which is discounted in the vortex theory on the grounds that it was disproved by the subsequent discovery of the neutron in 1932. This is explained in detail in *Was Einstein Right?*

In the vortex theory the ball vortex is thought to set up the three dimensional extension of mass and space. This because the extending energy in one ball vortex could set up the extension of space in which another ball vortex could move. This possibility is suggested by the success of Pauli's fourth quantum number when he applied Einstein's theory of relativity to his equations. Einstein's theory of relativity is easy to understand if every

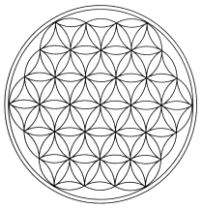
subatomic vortex is imagined to exist as a system of movement relative to the extension of space provided by other subatomic vortices rather than the void of absolute space imagined in the philosophy of classical scientific materialism.

Prior to Einstein it was assumed that everything moves relative to an absolute void of space. Einstein refuted that idea and in his special theory of relativity he proposed that everything moves relative to everything else. The vortex account for quantum spin, providing a visual image of Einstein's relativity operating at a quantum level has the additional advantage of bringing together quantum theory and relativity theory in a way that is easy to grasp. The way quantum theory and relativity theory are melded in the vortex theory speaks well in its favour.

Fig. 10. Albert Einstein

Because vortices of energy are dynamic as they overlap they would interact. Vortex interactions could account for the forces acting between subatomic particles. The primary interaction between subatomic particles is electric charge. The plus and minus values that apply to electric charge are congruent with the plus and minus values that apply to quantum spin. That fact supports the idea that quantum spin is the spin of energy forming a charged particle rather than the spin of a particle. The fact that electric charge appears to extend into infinity suggests that vortices of energy are infinite extensions. The infinite extension of vortex energy could account for action at a distance between charges particles, which Einstein described as *spooky*. Electric charge was also a problem for Heisenberg, Pauli and the other architects of quantum mechanics. As Pauli put it:

> "The crux of the problem was that the concept of electric charge was foreign to both pre quantum and quantum physics. In both theories the charge of the electron had to be introduced into equations- it did not emerge from them." [7]



The vortex of energy theory provides visual images to depict electric charges and present quantum physics in a graphic way. It is an artistic approach to physics that compliments mathematics with simple imaging of inertial mass as three dimensional gyroscopic spin and electric charges as interlacing and interacting concentric spheres of energy that extend into infinity. The interactions of vortices of energy are depicted in an image known as *the flower of life* which is considered to represent the laws of the Universe stretching into infinity.

Fig. 11. The Flower of Life

But what is infinity. Is it endless or does it turn back on itself. The answer to that question lies in Heisenberg's discovery of the half quantum, which supports an idea that popped out of Paul Dirac's equations that the Universe could be split between matter and antimatter. Wolfgang Pauli, Werner Heisenberg and Paul Dirac, with their brilliance in mathematics and their intuitive flashes, created quantum mechanics. If the outcome of their genius is configured around the quantum vortex of energy rather than the uncertainty principle then it becomes clear how their impetus could play a vital part in the unravelling of the knot of infinity between matter and antimatter and thereby redefine quantum gravity. This is outlined in ***The Power of Yoga in Physics*.**

Fig. 12. Paul Dirac

1. Miller A. *137: Jung, Pauli, and the Pursuit of a Scientific Obsession,* P.63., W. W. Norton & Company, 2010
2. Miller A. *137: Jung, Pauli, and the Pursuit of a Scientific Obsession,* P.62., W. W. Norton & Company, 2010 Yogi
3. Ramacharaka, *An Advanced Course in Yogi Philosophy and Oriental Occultism,* The Yogi Publication Society, 1905
4. Harvey A. *Hidden Journey* Rider, 1991.
5. Miller A. *137: Jung, Pauli, and the Pursuit of a Scientific Obsession,* P.64., W. W. Norton & Company, 2010
6. Feynman R. *The Character of Physical Law*, Penguin 1992
7. Miller A. *137: Jung, Pauli, and the Pursuit of a Scientific Obsession,* P.252., W. W. Norton & Company, 2010