*SECTION 4*

# *The Paradox*

*Point #1*

Section 3 ended with a summary that:

- Via causal analysis the three phenomena that gave birth to Quantum Mechanics were free of natural quantum effects.

- There is no causative support for the Quantum Mechanics denial of classical mechanics Locality and Realism.

Those are, in effect, statements that Quantum Mechanics lacks causation and is therefore not valid.

*But Point #2*

Numerous various experiments of various kinds, conducted by various different scientific groups over a number of years have all reported procedures and results consistently claiming violation of the principles of Locality and Realism.

Examples of these range from the EPR experiment and tests of Bell's Theorem to modern reports of quantum computers functioning successfully.

*The Paradox*

In other words the necessity of cause renders Quantum Mechanics invalid and any reported claims otherwise are in error.

Which is contradicted by that a large number of independent scientific demonstrations of Quantum Mechanics in action have been conducted.

The following analysis and comparison of classical mechanics versus Quantum Mechanics leads to resolving the paradox.

## *Quantum Mechanics Inherent Uncertainty*

By the very nature of the Quantum Mechanics principles, that particles do not experience specific manifestation until one of their superposed states is selected by measurement or observation, there is inherent uncertainty in both the initial conditions and the subsequent results of any Quantum Mechanics experiment or action as follows.

### *Uncertainty in Entanglement*

- In the process of creating a quantum entanglement it is difficult to ensure that the entanglement has been achieved. That is because the achieving of entanglement can only be verified by measurement on or observation of the particles involved. But, that very act of measurement or observation causes decoherence and collapse loss of the entanglement.

- The commonly used solution to that problem is to not use measurement or observation to verify the entanglement but, instead, to use a procedure to achieve the entanglement that has been shown to be largely successful in the past. The procedures so used, while largely reliable in the past can be subject to error. In any case verification is lacking and therefore there is consequent uncertainty

- Consequently there is always uncertainty as to whether the intended process or action is the one achieved.

### *Uncertainty in Measured / Observed Results*

- The results of a Quantum Mechanics experiment or action are obtained by measurement / observation of the end-product particles. That process always results in obtaining the value by provoking the collapse of the particle's wave function to a selected state out of the total superposition of the particle's states.

- That process is irreversible so that only one single initial reading of the output results is possible.

- It is also uncertain in that there is no guarantee that the resulting state selected is the one that validly reflects the experiment / action result.

The table below compares the attributes of Classical Mechanics and Quantum Mechanics.

| Comparison | Classical Mechanics | Quantum Mechanics |
|---|---|---|
| Claimed Phenomena | All experimentally provable and proven. | Some aspects are not objectively testable. |
| Objectivity of Results | Experimental results are largely numerical and not subject to opinion | Results are mostly subject to various alternative interpretations |
| Status as a Science | Scientific community is in full agreement on basic principles | There are several alternative interpretations as to what it means |
| Validity of Results | Generally probably objective | Uncertainty and limited objectivity |
| Assumptions | In general validated | In general unsupported |

Given Quantum Mechanics inherent uncertainty and limited objectivity and the validity of the above Point #1, Quantum Mechanics lack of supporting causation and mechanism, therefore …

The only reasonable resolution of the paradox is that there are mistakes in the Quantum Mechanics interpretation of its experimental set ups, procedures, and results, mistakes primarily in interpretation and caused also by Quantum Mechanics arbitrary and unjustified assumptions..

An example of such a Quantum Mechanics error in interpretation is

The Stern-Gerlach Experiment

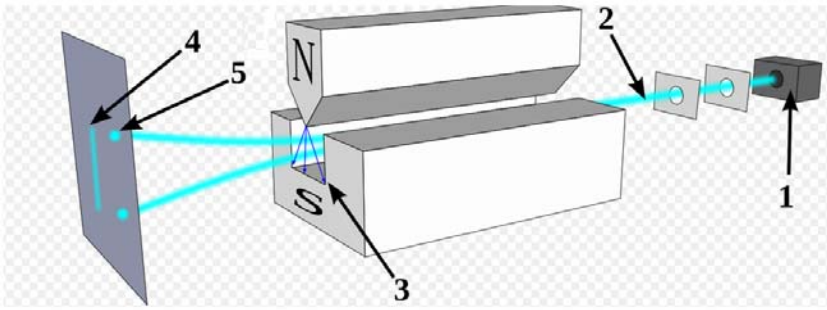
As its name suggests, particle spin was conceived of as the rotation of a particle around an internal axis. This spin is deemed to obey the same mathematical laws as quantized angular momenta do but on the other hand, spin has some peculiar properties that distinguish it from orbital angular momenta.

Particles with spin can possess a magnetic dipole moment, just like a rotating electrically charged body in classical electrodynamics. Or, rather, individual particles exhibiting a magnetic dipole moment are deemed to be particles having “spin”. These magnetic momenta can be experimentally observed in several ways, e.g. by the deflection of particles by inhomogeneous magnetic fields in a Stern-Gerlach experiment, or by measuring the magnetic fields generated by the particles themselves.

If the particle is treated as a classical magnetic dipole as it moves through a homogeneous magnetic field, the forces exerted on opposite ends of the dipole cancel each other out and the trajectory of the particle is unaffected.

However, if the magnetic field is inhomogeneous then the force on one end of the dipole will be slightly greater than the opposing force on the other end, so that there is a net force which deflects the particle's trajectory.

The Stern-Gerlach experiment is normally conducted using silver atoms. That is because silver can be melted and then vaporized at a relatively low temperature. In the Stern-Gerlach experiment, figure below, silver is vaporized at a high temperature such that the atoms of the vapor are at high energy. Those atoms that escape from the furnace through a small aperture are collimated by further apertures into a narrow beam of silver atoms. The beam is then directed into an inhomogeneous magnetic field.




*The Stern Gerlach Experiment*

1 – Furnace 2 – Collimated beam 3 – inhomogeneous magnetic field
4 – Expected (not quantized) result 5 – "Quantized" result

If the particles were classical spinning objects, one would expect the distribution of their spin angular momentum vectors to be random and continuous. Each particle would be deflected by an amount proportional to its magnetic moment, producing some continuous density distribution on the detector screen. Instead, the particles passing through the Stern-Gerlach apparatus are deflected either up or down by a specific amount as shown in the figure.

This was interpreted to be a measurement of the quantum observable now called spin angular momentum, which demonstrated the possible outcomes of a measurement where the observable has a discrete set of values.

Historically, this experiment was decisive in establishing the physics concept of the reality of angular momentum quantization in all atomic-scale systems. It was the justification for contending that the stable atomic electron orbits were those for which the orbital angular momentum was an integer multiple of a fundamental angular momentum of $h/2\pi$ [corrected in the preceding section 3].

Now it shall be found that "spin" and quantized angular momentum are not what is involved in the apparently quantized result of the Stern-Gerlach experiment, as follows.

### *THE CAUSE OF THE STERN-GERLACH APPARENT QUANTIZATION*

In the Stern-Gerlach experiment the metal silver is an excellent conductor of electricity. The reason is that its outermost orbital electron is very loosely bound to its atom. As a result that electron tends to become a free electron able to readily travel within the silver metal in which it is found. As the temperature and, therefore, energy increases in the quite hot and energetic silver vapor of the furnace the silver atoms of the collimated beam are mostly ionized, lacking that outer orbital electron.

Those positive silver ions flowing in a collimated beam constitute an electric current. And, in accordance with Ampere's Law that current results in a concentric magnetic field making each flowing silver ion a magnetic dipole. It is not "spin" nor a "natural property" of particles that produces the magnetic dipole, it is merely Ampere's Law and the ionized silver atoms.

But, the electrons lost by the ionized silver atoms are still present and flowing in the collimated beam. The beam is overall electrically neutral. That means that some of the silver atoms temporarily acquire an extra electron and become negative ions. And, the Ampere's Law magnetic field of the negative ion current flow produces a magnetic dipole directed opposite to that of the current of positive ions.

The collimated beam of silver atoms is a beam of magnetic dipoles of equal strength and opposite orientations. The strength of each is due to either one electron too few [for positive ions] or one electron too many [for negative ions], an apparent natural quantizing of the magnetic dipoles and therefore of their consequent deflection in the inhomogeneous magnetic field.

That effect, that the silver atoms appear to have "spin" and quantized angular momentum, is due to their loosely bound outer electrons and their migration within the silver atom beam resulting in individual positive and negative silver ions' local Ampere's Law currents and consequent magnetic dipoles. Essentially the apparent quantization is due to one electron too many versus one electron too few.

### *THE END OF PARTICLE "SPIN" AND ITS QUANTIZED ANGULAR MOMENTUM*

In discussions of Quantum Mechanics a property of particles identified as "spin" and involving angular momentum occurs frequently as for example a referring to "spin up" or "spin down" as quantum angular momentum 'states'. In those discussions it is often stated that no specific rotary motion (spin) is necessarily involved but that rather some intrinsic property of the particle being treated, an electron or an atom, is what is intended.

That intent is that quantized angular momentum is a natural property of particles such as electrons or atoms and that is contended in spite of there being no cause or mechanism for the particles in general to have that or such a property and with the actual denial that any physical spin as rotation about a central axis is present. That overall contention is defended by citing the Stern-Gerlach experiment.

But just above the analysis of the Stern-Gerlach experiment shows that there is no valid basis for contending that quantized angular momentum is a "natural property" nor any valid basis for the general attribution of "spin".

### *Then What About "Spintronics"*

Spintronics is the study of the "intrinsic spin" of the electron and its associated magnetic moment. The electron is a negatively charged particle that is always in motion. The most frequent appearance of its motion is in atomic electron orbits. But, free electrons are abundant, never at rest, always in curvilinear motion and that motion is effective as an electric current which results in a magnetic moment, which is the subject of spintronics.

Spintronics is not about a "natural occurring property" of electrons but merely the effect of it being a charge in constant motion acting per Ampere's Law. That is not a new Quantum effect, merely the classical action of classical physics. Any apparent quantization must be accounted for by some cause, some mechanism. It cannot appear without cause or mechanism as simply a "natural property".

## *Conclusion*

The resolution of the paradox is that

the Quantum Mechanics understanding and interpretation of its experiments

is in error due to the inherent uncertainty in Quantum Mechanics and

its unjustified assumptions.