A note on the understanding of Quantum Mechanics

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Abstract. Quantum Mechanics is understood by generalizing models for cause-effect from functions, e.g. Differential Equations, to graphs and, via linearization, to linear operators.

This also leads from classical logic to quantum logic.

1 Introduction

Quantum Mechanics is considered difficult to teach [1], as well as difficult to understand. The author's opinion is that the former is caused precisely because of the later.

The essence of this difficulty consists in us being used to *Y or N* answers to questions, which is a reduction of a complex situation to a binary model, requiring a choice, and when the question does not correspond to a natural projection [2].

Probabilities extend the range to the interval $[0, 1]$, while QC extends it to qubits: 3D balls.

Cause-effect is modeled via functions, with correlations between Input x and y in the range as being 0 or 1, if $y = f(x)$.

When several input factors contribute to a complex output via a process, networks are mandatory, or when modeling lists as vectors, to linear operators.

2 Collapse of the Wave Function

heisenber's QM via operators and Schrodinger's Wave mechanics via densities of probabilities are equivalent.

The key debate was the significance of the wave function, representing an amplitude of probability and its probability, measuring for instance the probability of a particle to be present at a certain place q.

The collapse of the wave function was considered not as a real process. Yet in an interaction, for instance the transfer of an elementary electric charge, is a network process, with the electron being an open fermionic channel. The closed channel case is that of an orbital. The measurement is a localized interaction that will collapse the channel, a cloud orbital-like, to the corresponding point of output. Hence the collapse is real.

Modeling an electron as a fermionic channel solves also the "mistery" of the double slit experiment [3].

This way of thinking also allows to model a photon as a bosonic excitation traveling on the fermionic channel, unifying bosons and fermions; this is a realistic alternative to the just mathematical way, supersymmetry.

3 Double Slit Experiment

As an example, consider the double slit experiment for an electron. The electron viewed as a point-particle leads to a contradiction. Wave-particle duality is an early stage model for solving this paradox. Modeling the electron as a material fermionic chanel with non-trivial topology (genus $g = 1$, with two punctures: I/O) not only solves the problem, but also solves the photon double slit experiment case, and, as remarked above unifies fermions and bosons.

In addition, the measurement via a photon means a new fermionic chanel is generated from the measurement apparatus, connecting with one arm of the genus one fermionic channel of the electron, redistributing it to one side only.

4 Conclusion

Evolving our understanding of reality from functions to networks as models of cause-effect phenomena leads naturally from Classical Physics to *the* Quantum Mechanics formalism. It is also obvious that an "effect", i.e. an output of a process, may be more complex then a pointwise, localized measurement and may require an adequate model: the Network.

The use of complex numbers as coefficients is mandatory to have periodic processes, i.e. waves, localized as particles too. But this is just the shadow of $SU(2)$ as the space of qubits, i.e. the quantum units of information $q = z_1|Y> +z_2|N>, |z_1|^2 + |z_2|^2 = 1$, in order to have superpositions of classically disjoint alternatives: "Yes AND No" at the same "time" and "place". Mathematically it enables products and coproducts of elementary events, i.e. classical functions and multivalued functions, to build graphs. Together we get the Hopf bundle and the Bloch sphere as a homogeneous space $U(1) \to SU(2) \to S^2$. This is the modern unit of Quantized Space-Time of General Relativity: not only a local time / "clock" (once we have an associated frequency $e^{i\omega t}$, built into the particles quantum phase: see Feynman's QED), but also a local space-frame. Weyl's gauge theory provides the connection between these, including the "synchronization" of clocks introduced by Einstein.

Returning to the qubit idea as a generic unit of "everything", note that this is just the foundation of ancient Chinese Tao philosophy, considering Yin-Yang polarity as primary. Together with ancient Greek's atom hypothesis and Zeno's paradoxes ruling out infinitite divisibility of action, and hinting to Planck's constant, we see how far pure thought can advance on its own, without asking "Mother Nature" with more and more sophisticated experiments.

The Network approach solves many other apparently paradoxical situations, including the collapse of the wave function and the double slit experiment. For further details, see [3, 4].

References

[1] Ian Durham, Teaching Quantum Concepts, Physics Today, Jan. 2022, pp.10-11.

[2] G. Birkhoff and J. von Neumann: "The logic of quantum mechanics", Annals of Mathematics 37 (1936), 823–843

[3] L. M. Ionescu, A Note on Manifolds VS Networks as Mathematics Models in Modern Physics, https://vixra.org/abs/1912.0095

[4] L. M. Ionescu, On the arrow of time, https://arxiv.org/abs/0708.4180

[5] F. Kapra, The Tao of Physics: An Exploration of the Parallels Between Modern Physics and Eastern Mysticism, 2010.

[6] R. Feynman, QED: The Strange Theory of Light and Matter, 1988.