Quantum Interpretation of the Impedance Model

Michaele Suisse and Peter Cameron
Strongarm Studios
Mattituck, NY USA 11952
michaele.suisse@gmail.com, petethepop@aol.com

Abstract: Quantum Interpretations try to explain emergence of the world we observe from formal quantum theory. Impedances govern the flow of energy, are helpful in such attempts. We include quantum impedances in comparisons of selected interpretations.
OCIS codes: 000.6800, 270.5585

1. Introduction

The quantum materialist sees life and consciousness as emergent phenomena, arising from the constituents comprising the formalism of quantum theory. Already, at the simplicity of the water molecule and the complexity of the Eskimo's hundred words for snow, the mind is staggered by the exponential magnitude and beauty of this possibility.

All the way up the chain, from the photon and its interaction with the electron to the philosopher contemplating it from bit, the dynamics may be more (photon) or less (philosopher) completely described in terms of the flow of energy. Impedances govern that flow. At the quantum level these impedances are quantized. Consideration of quantum impedances is relevant in the attempt to explain emergence of the world we experience from formal quantum theory. In what follows we focus on the remarkable insights available from this new perspective.

This note is organized around the table on the next page [1]. Effort was given to minimizing the number of interpretations, balancing perceived relevance against popularity as determined by surveys [2], with some deference to those chosen by the editors of a recent definitive compendium [3] and their emphasis on the measurement problem.

2. The Categories

In what follows we introduce the role of impedances in each of the categories shown in the chart.

2.1. *Local?*

Quantum impedances [4] are both local and non-local.

The scale invariant impedances (photon far field, quantum Hall, centrifugal,...) are non-local. They cannot do work, cannot transmit energy or information. They only communicate phase, not a single measurement observable. They are the channels linking the entangled eigenstates of non-local state reduction. They cannot be shielded [5].

The scale dependent impedances (Coulomb, dipole,...) are local. They do the work, transmit energy/information.

2.2. *Probabilistic?*

Quantum impedances are both probabilistic and deterministic.

They are probabilistic in the sense that the probabilities are determined by relative impedance matches.

They are deterministic in the sense that the probabilities are *determined* by the relative impedance matches. This determinism removes some of the mystery from the probabilistic behavior, illuminates in some small measure the inner workings of the collapse of the wave function.

2.3. *Hidden Variables?*

There are no hidden variables in the quantum impedances view. Their role is taken by the invariant impedances.

2.4. *Wave Function Real?*

The wave function is complex, has information about both amplitude and phase. Quantum phase is not observable in a single measurement. The phase information is lost when the wave function is multiplied by its complex conjugate in the process of calculating probability in a single measurement. With many measurements the phase information is regained. This argues that the wave function is real, the many measurement qualification being rendered somewhat moot by the indistinguishability of free electrons, or more generally of quantum particles.

Index	Interpretation	Authors	non-local?	probabilistic?	hidden variables?	wavefcn real?	wavefcn collapse?	universal wavefcn?	observer role?	unique history?
34	Objective Collapse	GRW 1986, Penrose 1989	Yes	Yes	No	Yes	Yes	No	No	Yes
34	Transactional	Cramer 1986	Yes	Yes	No	Yes	Yes	No	No	Yes
34	Quantum Impedances	Cameron & Suisse 2013	Yes	Yes	No	Yes	Yes	No	No	Yes
28	Quantum Logic	Birkhoff 1936	agnostic	agnostic	No	agnostic	No	No	No	Yes
22	Ithaca	Mermin 1996	No	Yes	No	No	No	No	No	Yes
21	Relational	Rovelli 1994	No	Yes	No	No	Yes	No	No	agnostic
14	Consistent Histories	Griffiths 1984	No	agnostic	No	agnostic	No	No	No	No
12	Copenhagen	Bohr & Heisenberg 1927	Yes	Yes	No	No	Yes	No	Yes	Yes
10	Orthodox	von Neumann 1932	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
-7	de Broglie – Bohm	de Broglie 1927, Bohm 1952	Yes	No	Yes	Yes	No	Yes	No	Yes
-8	Many Worlds	Everett 1957	No	No	No	Yes	No	Yes	No	No

Fig. 1. Comparison of the Interpretations. The Index parameter quantifies the strength of agreement between a given interpretation and the rest of the table. Values in the Index column are calculated by adding a point for entries that agree with a given interpretation, subtracting for entries that disagree, and giving half values for the agnostics.

2.5. *Wave Function Collapse?*

Collapse of the wave function is at the core of (and easily interpreted in terms of) quantum impedances. It follows from decoherence, from differential quantum phase shifts between the coupled modes that permit propagation. The quantum phase shifts result from interaction between the wave function and quantum impedances. This is what complex impedances do. They shift phases. Quantum impedances shift quantum phases.

2.6. *Universal Wave Function?*

As the term is commonly understood, there is no universal wave function in the impedance model. However, there is some sense in which the quantum impedance networks associated with massive particles have an encompassing universality, and particularly those associated with the electron and the Planck particle [4]

2.7. *Observer Role?*

Quantum impedances are background independent. The method of calculating quantum impedances derives from consideration of the two body problem and Mach's principle [4]. There is no observer in the two body problem.

2.8. *Unique History?*

Conservation of energy dictates a unique history. The paths followed by energy as it flows through the impedance networks are deterministic and unique, uniquely determined by the relative impedances. Probabilities enter only when one interrupts the flow to make a measurement.

3. Discussion

3.1. *Time Symmetry*

The impedance model is not time symmetric, with symmetry being broken (not always?) in collapse of the wave function. Regrettably, there is no chart column devoted to the interesting topic of time symmetry in quantum theory.

One might argue that a probabilistic theory cannot be time symmetric, unless one makes the backward wave deterministic (which of course breaks the symmetry). Without this restriction time symmetry is probabilistic as well, randomly symmetric and non-symmetric, dependent on probabilistic coincidence in the independent probabilistic collapses of the forward and backward waves. This argument appears to hold for both deBroglie-Bohm and MWI, but not for the transactional interpretation. However, if one restricts the time symmetry to the invariant impedances, then weak measurement theory [6] opens new possibilities [5].

3.2. *Counterfactual Definiteness*

It is claimed that Bell's Theorem proves [7, 8] that quantum theory must violate *either* locality *or* CFD. A column in the table for CFD would then simply be the same as the non-locality column. This seems to be in serious conflict with the earlier analysis [1]. For this reason there is no CFD column in the table.

3.3. *The Many Worlds Interpretation*

Many MWI advocates proclaim the physical reality of the exponentially multiplying worlds. The obvious exponential violation of conservation of energy is rationalized by the claim that conservation of energy is only required in the individual universes, and may be exponentially violated in the multiverse. This is a splendid illustration of the desperation to which we are reduced in the face of the measurement problem. The desperation diminishes if we say that we are coupled (if at all) to the multiverse only by quantum phase, by the unshieldable scale invariant impedances.

4. Conclusion

The most difficult task in developing the impedance model is getting physicists to think in terms of impedances. Surprising, as we think quite well in terms of energy, but historically have overlooked that which governs the flow of energy. In the present context, quantum impedances provide a new, simple (once the initial unfamiliarity is overcome) and intuitive perspective on nonlocality, determinism, hidden variables, state reduction,.. In the larger sphere they offer insight into such diverse phenomena as the spectrum of unstable particles seen at our high energy colliders, and quantum gravity [4]. An immediate hope is that they might shed light on the mystery of proton spin [9, 10]. There is a certain urgency to this, as RHIC (the world's only high energy polarized collider) twists in the budgetary winds.

5. Apologia

While we are convinced that the impedance model is useful to the Quantum Interpretations community and thereby obligated to share what we may, we ourselves are not established members of that community and make only the most modest of claims to expertise. We welcome and very much appreciate guidance, criticisms, comments, and corrections - and particularly corrections to the comparisons table.

References

1. http://en.wikipedia.org/wiki/Interpretations_of_quantum_mechanics
2. T. Norsen and S. Nelson, "Yet Another Snapshot of Foundational Attitudes Toward Quantum Mechanics", and references therein. http://arxiv.org/abs/1306.4646
3. D. Greenberger, K. Hentschel, and F. Weinert, *Compendium of Quantum Physics*, Springer (2009).
4. P. Cameron, "A Possible Resolution of the Black Hole Information Paradox", Rochester Conferences on Coherence and Quantum Optics and Quantum Information and Measurement (2013), and references therein. http://www.opticsinfobase.org/abstract.cfm?URI=QIM-2013-W6.01
5. P. Cameron, "Delayed Choice and Weak Measurement in the Nested Mach-Zehnder Interferometer", these proceedings.
6. Y. Aharanov and L. Vaidman, "A New Characteristic of a Quantum System between Two Measurements - a 'Weak Value' ", in Bell's Theorem, Quantum Theory and Conceptions of the Universe, M. Kafatos (ed.) 17-22, (Kluwer, 1989)
7. H. Stapp, "S-matrix Interpretation of Quantum Theory", Phys Rev D 3 (6) 1303 (1971).
8. D. Albert, "Bohm's Alternative to Quantum Mechanics", Scientific American (May 1994).
9. Leader, E., "On the controversy concerning the definition of quark and gluon angular momentum", Phys. Rev. D 83, 096012 (2011). http://arxiv.org/pdf/1101.5956v2.pdf
10. Aidala, C., "The Spin Structure of the Nucleon" (2012) http://arxiv.org/abs/1209.2803