Geometric Clifford Algebra and Quantum Interpretation of the Proton's Anomalous Magnetic Moment

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Abstract

The role of the anomalous moment in the geometric Clifford algebra of proton topological mass generation suggests that the anomaly is not an intrinsic property of the free space proton, but rather a topological effect of applying the electromagnetic bias field required to define the eigenstates probed by the magnetic moment measurement. Quantum interpretations strive to explain emergence of the world we observe from formal quantum theory. This variant on the canonical measurement problem is examined in the larger context of quantum interpretations.

The Measurement Problem

The measurement problem asks whether or not, and if so how, wave function collapse occurs. The inability to directly observe wave function collapse has given rise to numerous quantum interpretations and poses a range of questions each interpretation must answer:

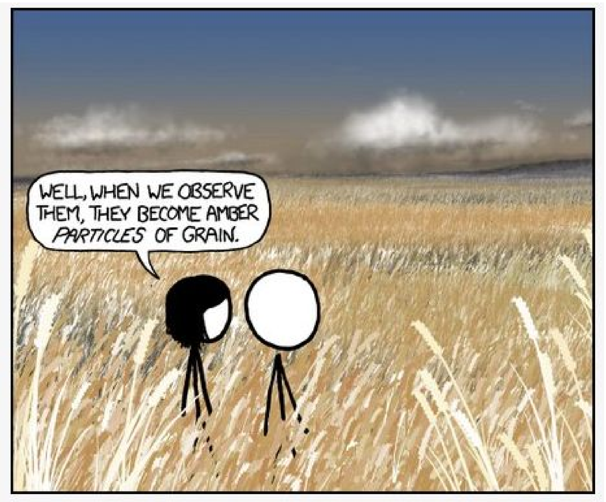


Figure 1.

- reality and observability of wave function
- reality and observability of wave function collapse
- deterministic and probabilistic wave function collapse
- superposition of quantum states
- entanglement of quantum states
- how to explain non-locality
- extent, if any, of hidden variables
- extent, if any, of an observer role

Quantum Interpretations

Those who tread the boundary between physics and philosophy consider an interpretation of quantum mechanics to be of the mathematical formalism, specifying the physical meaning of the mathematical identities - most particularly the reality and observability of the wavefunction.

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

Figure 2. Comparison of Quantum Interpretations.

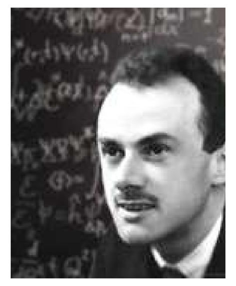
Appearance over the course of nearly a century of a growing number of quantum interpretations and areas of contention demonstrates our lack of a proper physical understanding of fundamental phenomena.

Impedance Quantization

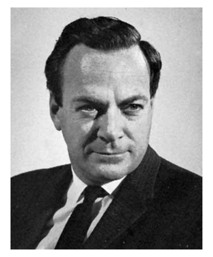
Impedance is defined as the amplitude and phase of the opposition to the flow of energy. While quite familiar to electrical engineers (Figure 3) and accelerator physicists, this fundamental concept is absent from the models and theories of particle physicists. Prior to discovery of the quantum Hall impedance in 1980, the concept of impedance quantization did not exist in physics. As a result, impedance quantization is absent from QED.

Figure 3. Ohm's Law

"Until we have a really satisfactory explanation of how electrons and photons interact with each other, it will hardly be possible to go on and explain the other particles."



To understand photon-electron interactions requires consideration of both photon near-field impedances and the many quantized impedances of the electron. Both are absent from the education of the PhD physicist, not to be found in the textbooks or any course materials.



"It's every physicists dream to do a calculation and have the Fine Structure Constant pop out!"

As shown below in figure 4, when given such consideration, the fine structure constant pops out.

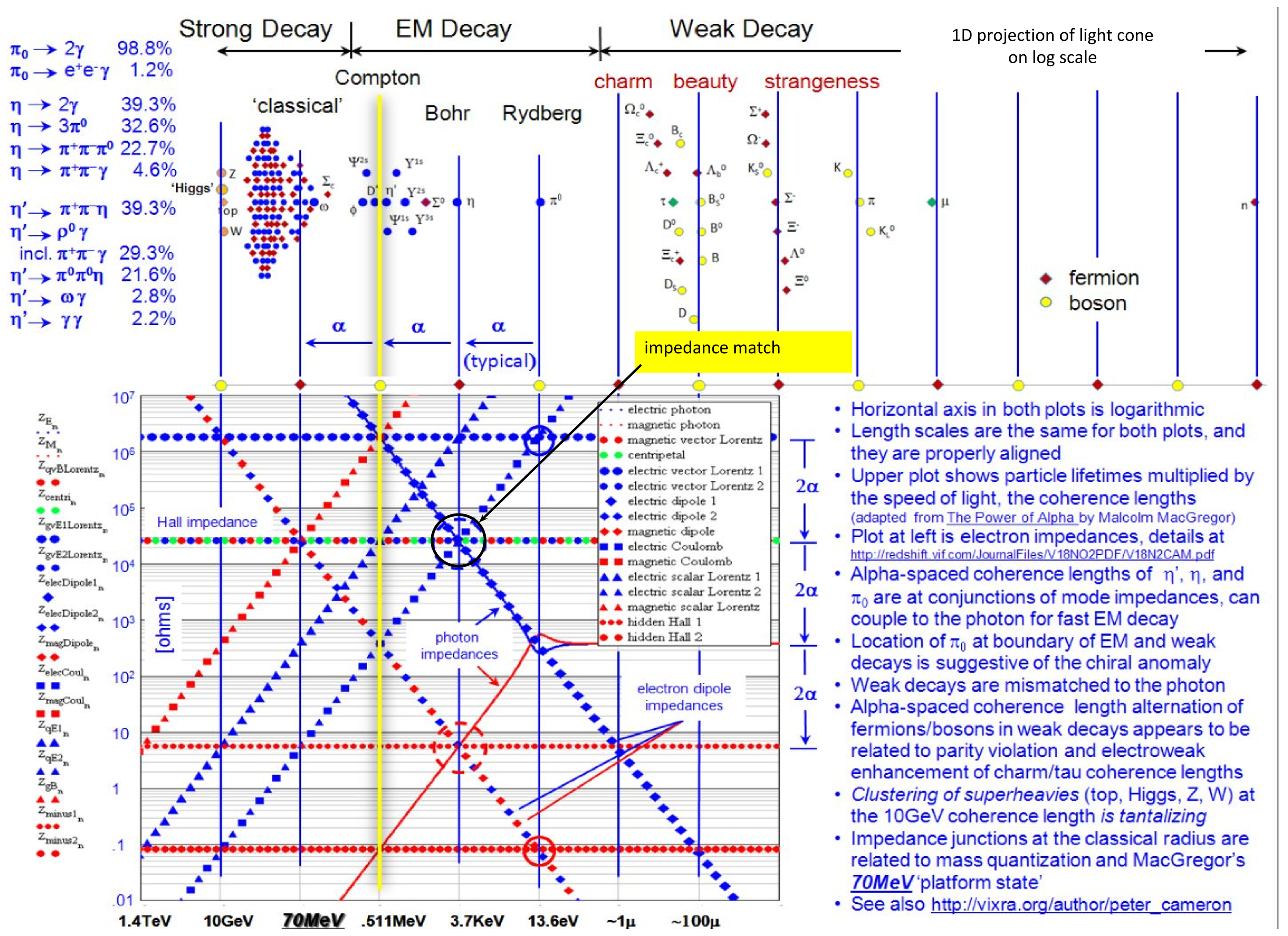


Figure 4. Correlation of unstable particle lifetimes/coherence lengths with alpha-spaced nodes of the quantized impedances of the electron, where impedances are matched and particles can decay.

Quantized impedances may be generalized beyond the quantum Hall effect to all impedances associated with all forces and potentials. Crucial for understanding the flow of energy is impedance *matching*. Impedances are matched at the mode conjunctions, at the alpha-spaced nodes. The matching of impedances, when energy flows without reflection, allows particle modes to decay.

Geometric Clifford Algebra & Electron Wavefunction

- The original intent of Clifford algebra was geometric. This was lost with the dominance of the matrix formalisms pursued by Pauli, Dirac and the mainstream after the early death of Clifford.
- David Hestenes recovered the work and brought it to physics in the 1960's, though the value of the work has only begun to be realized.
- In geometric algebra the **electron wavefunction** is the minimally complete Pauli algebra of 3D space endowed with electric and magnetic fields.

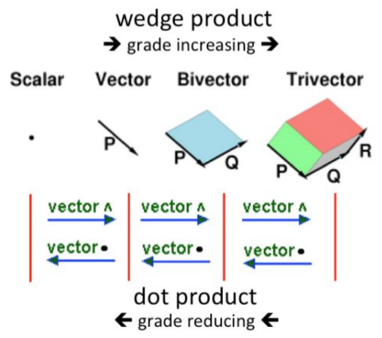


Figure 5. Pauli 3D algebra

The Anomalous Moment

By applying the tools of the impedance quantization and geometric Clifford algebra, the resulting analysis suggests the proton anomalous moment is not intrinsic. We define 'intrinsic' to mean that the modes comprising a quantum system are coupled, impedance matched and phase coherent.

If not a property of the proton, but rather an artifact of the measurement process, then one wonders to what extent the anomalous moment might fit the more general definition of an anomaly in QFT - the breaking of a symmetry which exists at a classical level. Anomalies for the most part follow from the need for renormalization, the chiral anomaly being a good example. The impedance approach is finite, with both low and high energy divergences being naturally cut off by the impedance mismatches. No need for regularization and renormalization.

Conclusions

- Impedance is a fundamental concept, universally valid. Absence of impedance quantization from QED is an historical accident.
- The impedance approach is finite, confined, and gauge invariant. The model requires just five fundamental constants: speed of light, Planck's constant, electric charge quantum, permittivity of free space, and electron Compton wavelength. There are no adjustable parameters.
- The impedance approach suggests the proton anomalous moment is not a property of the free space proton, and to understand proton spin cross sections we must work with the nuclear Bohr magneton.
- The ever-growing number of conflicting interpretations of quantum mechanics warrants attention by all disciplines of physics.
- The complementary tools of geometric algebra and impedance quantization provide a simple and effective formalism for analysis of the wave function collapse.
- The measurement problem and resulting contentions in quantum interpretations lose their mystery when examined in the manner presented here. What emerges is an understanding, both intuitive and explicit, of the wave function.

Also see: "mlsPosterVideo25Sep2016" *YouTube.*
https://www.youtube.com/watch?v=uyM4cZgSprl

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