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

Michaele Suisse and Peter Cameron

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 in quantum mechanics asks whether or not, and if so...how, wave function collapse occurs. The inability to observe wavefunction collapse directly has given rise to a growing number of interpretations of quantum mechanics and poses a key set of questions each interpretation seeks to answer (see column headers across the top of Figure 2 at bottom left of poster).

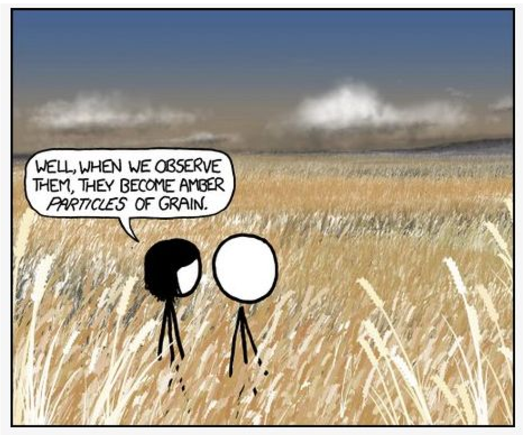


Figure 1.

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 Interprations.

The existence of a growing number of quantum interpretations and areas of contention amongst these interpretations spanning over the course of more than a century demonstrates our lack of a proper physical understanding of fundamental phenomena.

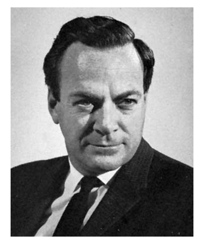
Impedance Quantization

Impedance is defined as the amplitude and phase of the opposition to the flow of energy. The concept is a familiar one to electrical engineers (Figure 3), yet much less so to high energy and particle physicists.

Figure 3. Ohm's Law

The absence of impedance quantization from QED appears to be a historical accident. Why is it evident now?

- Without the discovery of the quantum Hall effect in the 1980's the usefulness of impedance quantization was all but unrecognizable.
- The foundation given by an earlier work which rigorously examined the two-body problem and applied Mach's principle allowed calculation of mechanical impedances, then electrical impedances, and eventually the massive particle spectrum..
- The recognition of the absence of a near field photon in the literature and subsequent calculation of the impedance match of a free electron to a 13.6 eV photon resulting in the fine structure constant.



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

Quantized impedances may be generalized beyond the quantum Hall effect to elucidate impedances associated with all forces and potentials.

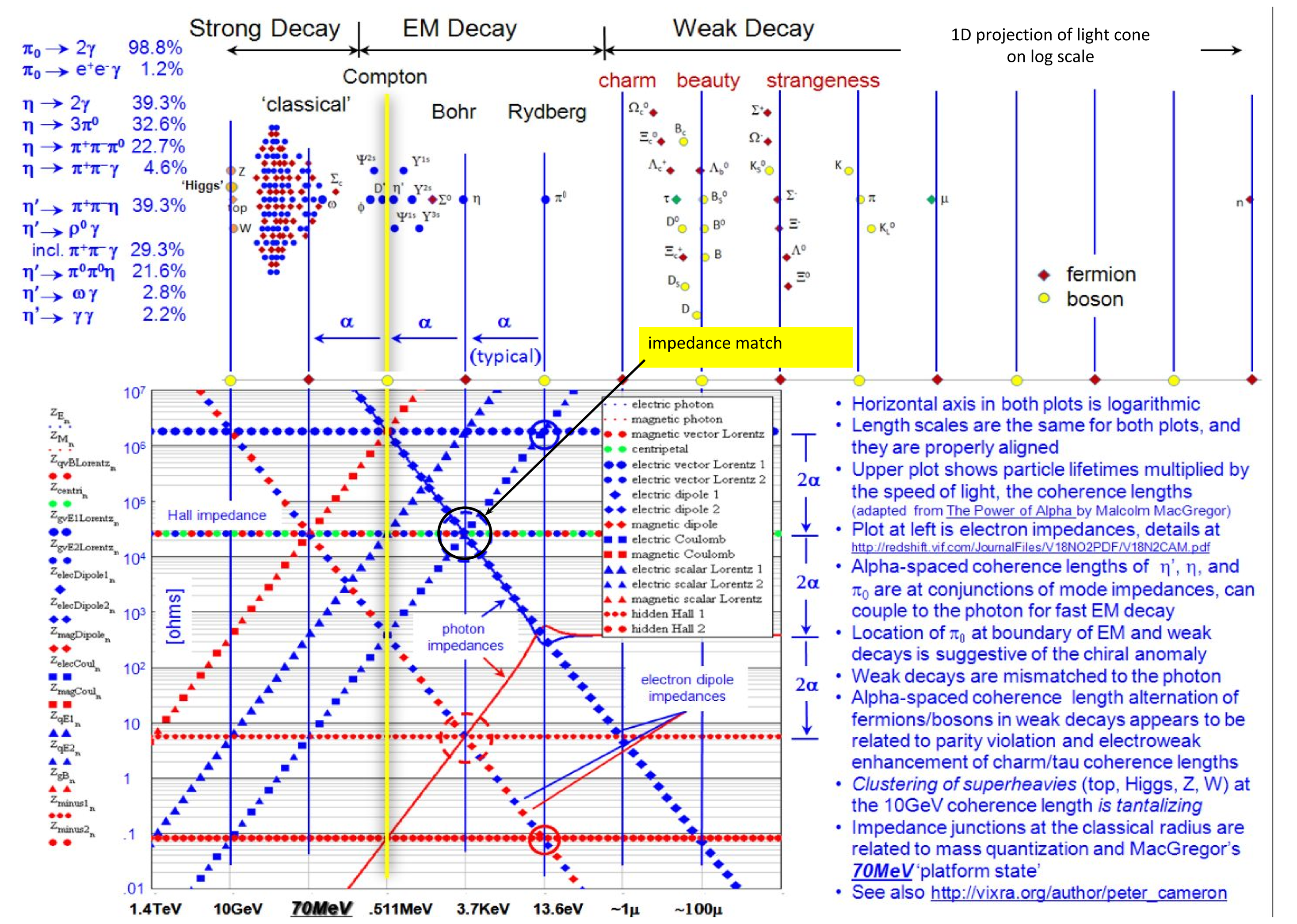


Figure 4. A composite of 13.6 eV photon impedances.

What is crucial for understanding the flow of energy is impedance matching. Impedances are matched at the mode conjunctions, at the nodes. Matching of impedance, when energy flows without reflection, allows particle modes to decay.

Geometric Clifford Algebra & Electron Wavefunction

- The original intent of algebra was geometric. This was lost with the dominance of the Gibbs vector formalism which was used 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 is only begun to be realized.
- Minimally complete Pauli algebra of 3D space endowed with electric and magnetic fields is is the electron wave function.

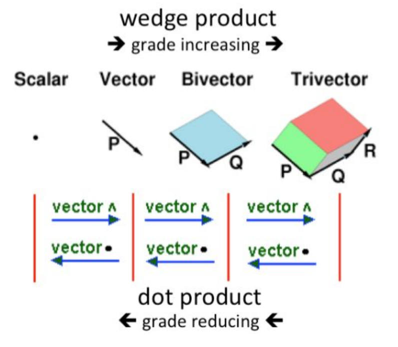


Figure 5. Pauli 3D algebra

The Anomaly

What is an anomaly? In physics, quantum mechanics, and quantum field theory, an anomaly is a breaking of a symmetry which exists at the classical level. Anomalies for the most part follow from the need for renormalization, the chiral anomaly is good example. In the Impedance Model there is no need for renormalization.

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

Conclusions

- The **Measurement Problem** and other areas of contention in quantum mechanics are less mysterious with the impedance worldview.
- The exponential growth of, and continued disagreement in, **interpretations of quantum mechanics** warrants attention by all disciplines of physics. Using the tool of quantized impedances and geometric Clifford algebra the areas of contention are addressable.
- Impedance is a fundamental concept with universal applicability. Absence of **impedance quantization** from QED is an historical accident. This combined with a topological oversight and the hazards of setting fundamental constants to dimensionless unity suggests the Impedance Model requires attention.
- **Geometric Clifford algebra** provides a simple and effective formalism for impedance analysis of the wave function collapse.
- The proton **anomaly** 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 **Impedance Model** is finite, confined, and gauge invariant. Requires just five fundamental constants: the speed of light, Planck's constant, electric charge quantum, permittivity of free space, and electron Compton wavelength. There are no adjustable parameters. There is also no renormalization, instead there is understanding of underlying structure.

Contact Information: michaele.suisse@gmail.com, electrongaugegroup@gmail.com