A Possible Resolution of the Black Hole Information Paradox – the Particle Physics Perspective*

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Abstract: Nonlocal reduction of entangled states is clarified by considering the role of background independent scale-invariant quantum impedances in decoherence of the unstable elementary particles, providing simple resolution of the black hole information paradox.

Introduction

Decay of the unstable particles offers the possibility of informing nonlocal reduction of entangled states. Both follow from phase decoherence (with the resultant complication that phase is not an observable in state reduction). Unlike entangled states, where unitary evolution of the two (or more) body wave function requires nonlocal phase coherence, in the case of the unstable particles the essential coherence is self-coherence.

The first concerted effort to understand the role of self-coherence in the unstable particle spectrum was implicit in S-matrix/string theory. That program, lacking both phase and mode information, was frustrated by the failure of the bootstrap to tie together the associated Feynman diagrams, and was superseded by QCD.

Superstring theory eventually emerged as the logical successor to the S-matrix, with the requisite fundamental length shifting from the nucleon scale to that of the Planck particle. As in the case of any quantum measurement, each of the 'dimensional' reductions of string theory yields an amplitude, with the corresponding loss of phase information.

Neither string theory nor QED/QCD provides satisfactory understanding of either state reduction or nonlocality.

Photon and Quantum Hall Impedances

The two quantum impedances common in the literature are the photon and quantum Hall impedances. The scale invariant quantum Hall impedance and the far and near field impedances [1] of a .511MeV photon are shown in figure 1.

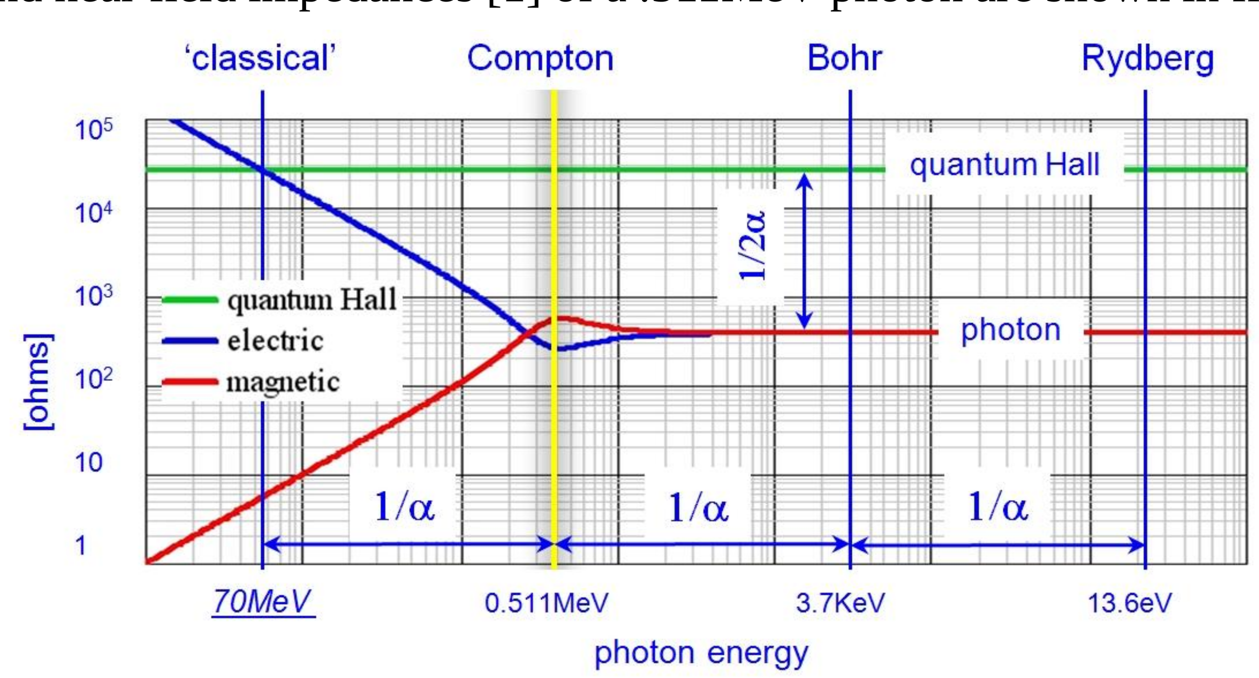

Figure 1. Photon and quantum Hall impedances

The role of the fine structure constant is prominent in both the impedance and energy/length scales.

Generalized Quantum Impedances and the Model

As every circuit designer knows, impedances govern the flow of energy. This is not a theoretical musing. It is particularly pertinent in quantum theory.

A novel method for calculating mechanical impedances [2], both classical and quantum, was presented earlier [3,4]. In that work a background independent version of Mach's principle emerged from a rigorous analysis of the two body problem, permitting simple and direct calculation of these impedances.

The two body problem is innately one-dimensional, populated by string-like topologies. The mechanical impedances can be converted to the more familiar electrical impedances by adding electric charge to these string-like objects [4,5].

Figure 2. A practical realization of the two body problem and Mach's principle

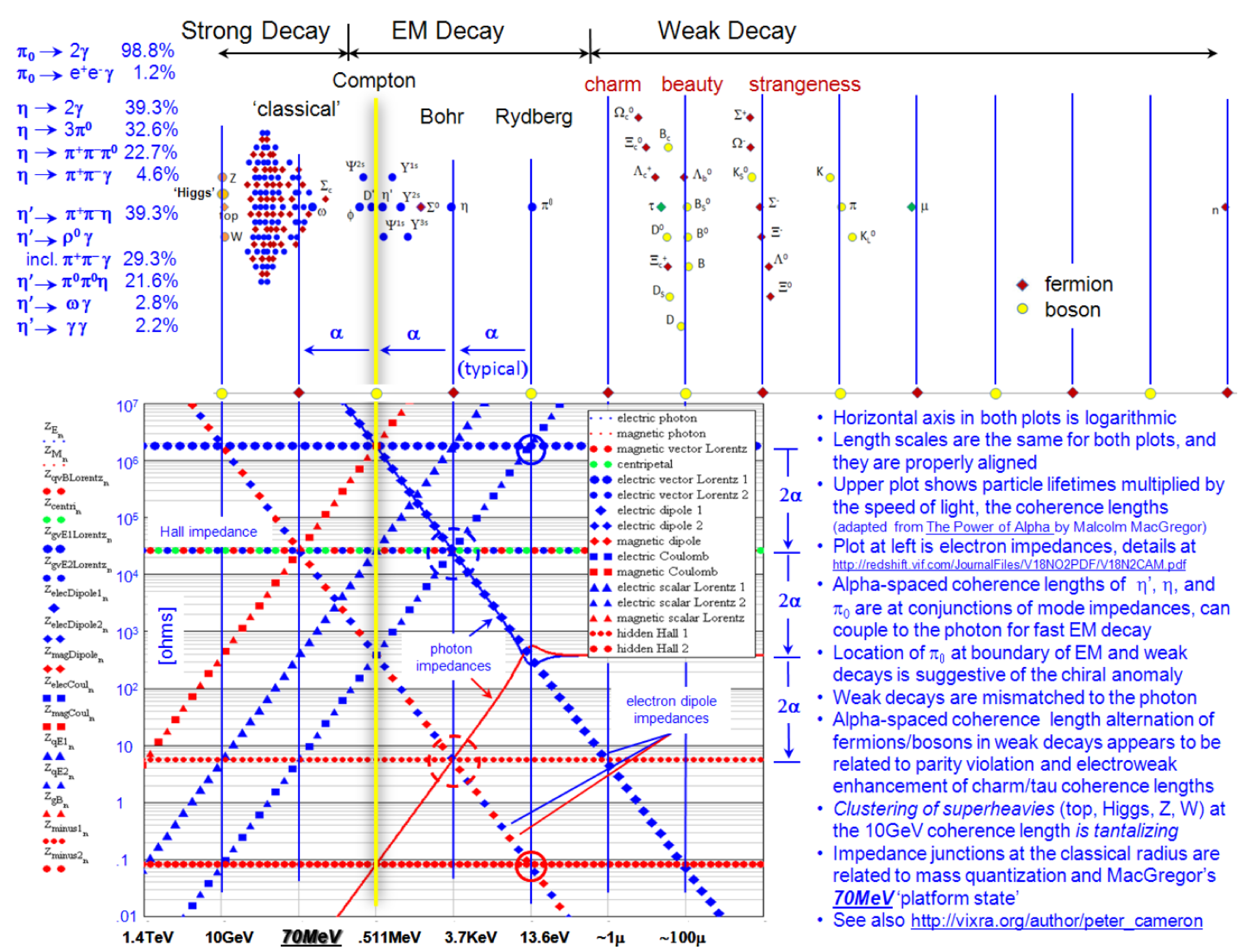

Figure 3. A composite of 13.6eV photon impedances[1] and a variety of background independent[3] electron impedances[4,5], measured branching ratios of the π^0, η, and η', the four fundamental quantum lengths shown in figure1, and the coherence lengths of the unstable particles[5-7]. Absent from the plot are the longitudinal dipole-dipole and longitudinal and transverse charge-dipole impedances.

This novel tool, this method of calculating impedances, is of no use to physics without a model to which it may be applied. The model adopted earlier [4-6] remains useful. It comprises

- quantization of electric and magnetic flux, charge, and dipole moment
- interactions between those topologies - flux quantum, monopole, and dipole
- confinement to a fundamental length, the Compton wavelength of the electron
- the photon

Calculated coupling impedances [3,4] of the interactions are shown in figure 3. The role of the resulting impedance network, the 'scattering matrix', in the phenomenology of the unstable particles was discussed in detail earlier [5].

The point here is that the coherence lengths of the unstable particles are defined by the conjunctions of the mode impedances. This apparent causal role in the creation and decay of the unstable particles lends credence to the conjecture that quantum impedances can be meaningfully applied to the measurement problem [6].

Entanglement and State Reduction

Special relativity requires that no energy is transferred in the nonlocal collapse of entangled wave functions, that no work is done, no information communicated. In the family of quantum impedances those which are scale invariant, the Lorentz and centrifugal impedances (operative in the quantum Hall effect) satisfy this requirement [6].

The centrifugal force is in some sense a mechanical equivalent of the vector Lorentz force. Like the Lorentz force, it is perpendicular to the direction of motion, and hence can do no work. The centrifugal impedance is numerically equal to the scale invariant quantum Hall impedance, and is plotted in figure 3 (green dots). Either or both of these two impedances might serve as a mechanism of nonlocal reduction of entangled states.

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From here it is a small step to collapse of the self-coherent wave function, via the phase-shifting scale-invariant Lorentz and centrifugal impedances of the Aharanov-Bohm effect.

The Planck Particle

The Planck particle may be brought into the impedance model by confining the electric and magnetic versions of the three quantized topologies (fluxon, monopole, and dipole) to the Planck length, rather than the electron Compton wavelength. A representative subset of the electron and Planck particle impedances is shown in figure 4.

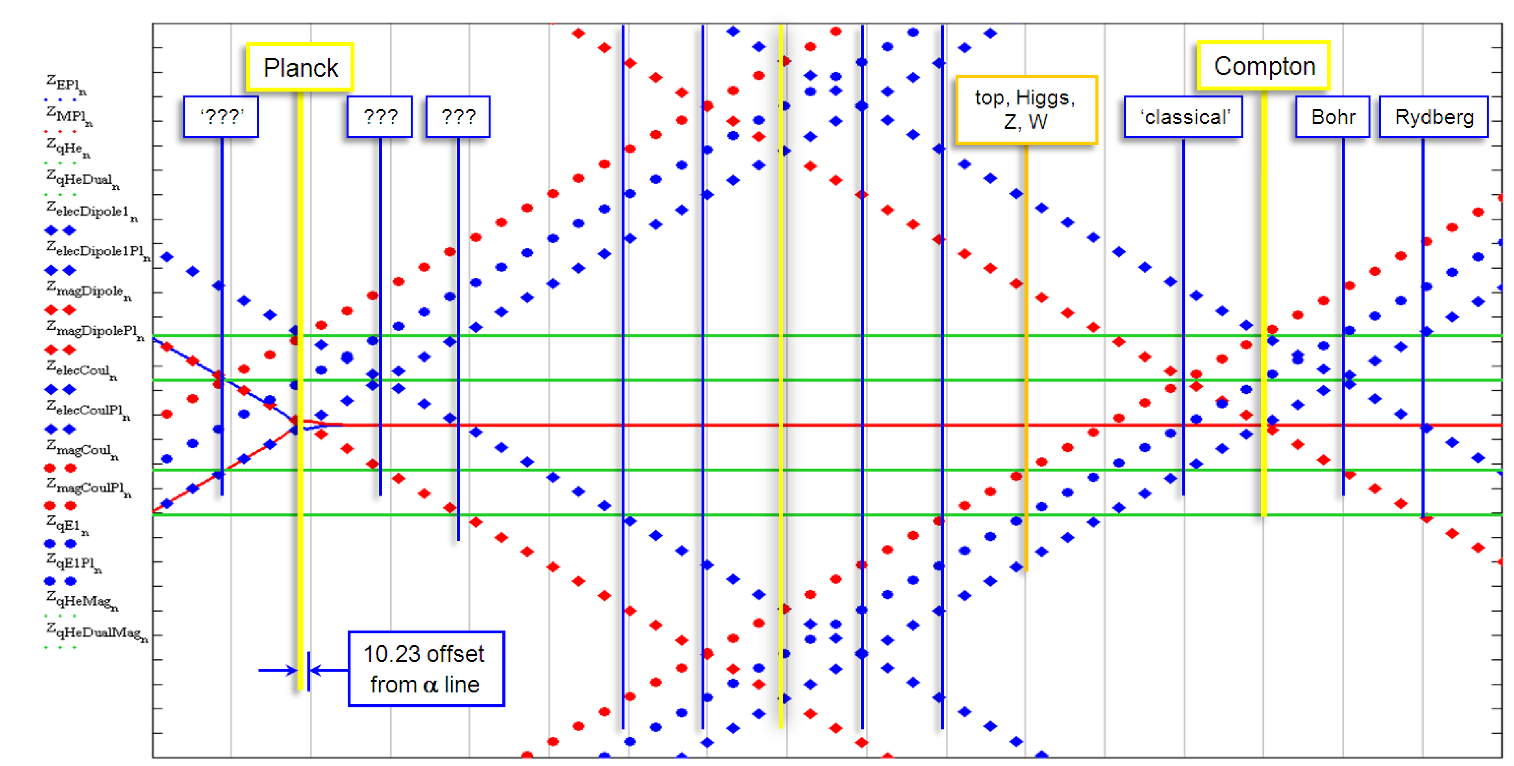

Figure 4. Impedances of the photon, electron, and Planck particle, the four fundamental lengths shown in figures 1 and 3, and the coherence lengths of the top, Higgs, Z, and W.

One wonders what if any relations exist between such a model and present day string theories.

The Black Hole Information Paradox

An earlier note [8] calculated the impedance mismatch between the electron and the Planck particle. This mismatch is precisely equal to the ratio of the gravitational and electromagnetic forces between these two particles, indicating that the quantum impedance approach is valid at the event horizon, and perhaps beyond, to the singularity (which is completely decoupled by the infinitely large impedance mismatch at the dimensionless 'point').

As regards the paradox, if the scale invariant impedances are valid at the event horizon and responsible for nonlocal state reduction, and the holographic principle applies, then the paradox is removed.

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References

1. Capps, C., "Near Field or Far Field?", Electronic Design News, p.95 (16 Aug 2001). http://edn.com/design/communications-networking/4340588/Near-field-or-far-field
2. Flertcher, N. and Rossing, T., The Physics of Musical Instruments, 2nd ed., Springer, p.19 (1998).
3. Cameron, P., "The Two Body Problem and Mach's Principle", submitted to Am. Jour. Phys (1975), in revision. The unrevised version was published as an appendix to the Electron Impedances note [4].
4. Cameron, P., "Electron Impedances", Apeiron, vol.18, no.2, p.222-253 (April 2011). http://redshift.vif.com/JournalFiles/V18NO2PDF/V18N2CAM.pdf
5. Cameron, P., "Generalized Quantum Impedances: A Background Independent Model for the Unstable Particles" (July 2012), http://vixra.org/abs/1207.0022
6. Cameron, P., "Quantum Impedances, Enganglement, and State Reduction", (November 2012). http://vixra.org/abs/1303.0039
7. MacGregor, M. H., The Power of Alpha, World Scientific (2007). see also http://70mev.org/alpha/
8. Cameron, P., "Background Independent Relations between Gravity and Electromagnetism" (November 2012) http://vixra.org/abs/1211.0052