

# Errors in the Quantum Electrodynamic Mass Analysis of Hagelstein and Chaudhary

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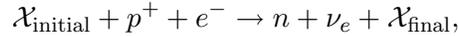
## Abstract

Hagelstein and Chaudhary have recently criticized our low energy nuclear reaction rates in chemical cells based on our computed electron mass renormalization for surface electrons of metal hydride electrodes. They further criticize our electron mass renormalization in exploding wire systems which is very strange because mass renormalization was *never even mentioned* in our exploding wire work. Here we show that the calculations of Hagelstein and Chaudhary are erroneous in that they are in conflict with the Gauss law, i.e. they have arbitrarily removed all Coulomb interactions in electromagnetic propagators. They have also ignored substantial Ampere interactions in favor of computing only totally negligible contributions. When the fallacious considerations of Hagelstein and Chaudhary are clearly exposed, it becomes evident that our previous calculations remain valid.

## 1 Introduction

Shortly after claimed evidence for the fusion of deuterium nuclei in room temperature chemical cells was withdrawn, the editors of *Nature* reported on subsequent claims[1] that large excess heats of reactions were found in chemical cells even when the heavy water was replaced with light water. In the last fifteen years or so, many experiments have reported low energy nuclear transmutations in chemical cells containing completely negligible amounts of deuterium[2, 3, 4]. To explain both the heavy water and light water cases, the present authors investigated alternative weak interaction modes of nuclear transmutations as opposed to the claimed strong interaction fusion of

deuterons. The grounds were in part that strong Coulomb barriers make highly improbable the fusion mechanism at room temperature in experimental heavy water systems and the lack of deuteron fuel make fusion virtually impossible in light water systems. The weak interaction mechanism being investigated involves the reaction



converting protons and electrons into neutrons and neutrinos. The subsequent neutron absorption by other nuclei induces nuclear transmutations. The quantum electrodynamic energy and mass renormalization required for the initial condensed matter environment  $\mathcal{X}_{\text{initial}}$  to feed electrodynamic energy into the neutron producing weak interaction has been previously discussed[5].

Recently, Hagelstein and Chaudhary have criticized[6] our calculations of mass renormalization and energy and claimed that our computed mass renormalization for surface electrons of metal hydride electrodes is too high. We here assert that the calculations of Hagelstein and Chaudhary are erroneous in that they are in conflict with the electric Gauss-Coulomb law. They further criticize our mass renormalization in exploding wires which confuses us since *we never even mentioned mass renormalization* in our exploding wire work[7].

(i) The error by Hagelstein and Chaudhary in violating the electric Coulomb law interaction is discussed in detail in Sec.2. However, let us here note that contrary to the Hagelstein-Chaudhary statement that electron energy shifts in the MeV energy range are “unprecedented”, the *fact* is that electron energy shifts in the MeV energy range are routinely calculated and measured. Consider the electric field ( $\sim 10^2$  megavolt per centimeter) within the surface dipole layer produced when a metal is in contact with an insulator. If the insulator were to slide across the metal, then the frictional electron charge transfer at the small regions of contact (total area  $\propto$  to the normal force) can support charge separation voltage differences as high as  $\sim$  ten megavolts. The resulting established experimental device is a “Van de Graaf Generator” and is very well known to produce discharge electron energies in the nuclear physics MeV range. While the Van de Graaf mechanism is roughly a DC surface charge separation, the surface plasmon excitations discussed by Widom and Larsen may be described as an AC surface charge separation. When sufficiently stimulated by a DC current source passing through the metal hydride surface of a chemical cell electrode, such AC charge separating plasmon excitations may also give rise to MeV electronic

energy shifts. Of course, to compute this effect, one has to include charge density oscillations in the mean square electric field  $\overline{|\mathbf{E}|^2}$ .

*Sadly, Hagelstein and Chaudhary throw away those parts of the electric field that arise from the charge density, i.e. those parts of the electric fields which can actually describe charge separation. Therein lies the Hagelstein-Chaudhary violation of the Coulomb-Gauss law. It would appear that Hagelstein and Chaudhary prefer to calculate Coulomb interactions employing the pencil eraser rather than the pencil writing point. Arbitrarily erasing the Coulomb barrier between two deuterons has been a common technique for some workers proposing the fusion mechanism at room temperature. For the weak interaction mechanism, the Coulomb interaction is a help rather than a hindrance.*

(ii) The error by Hagelstein and Chaudhary in violating the magnetic Ampere law interaction is discussed in detail in Sec.3. The long ranged and unscreened magnetic mean field contribution to the single electron annihilation chemical potential is *distinct* from a field fluctuation mass renormalization. However, we note that for narrow long current channels with currents larger than  $I_0 \approx 17.045089$  KA, nuclear transmutations have been observed on a variety of systems. These range from narrow wire explosions[8, 9, 10, 11, 12, 13, 14] to neutron generating lightning bolts[15]. The current  $I_0/c = R_{vac}I_0/4\pi = mc^2/e$  is the measure used by Alfvén for the electron rest energy.

## 2 Electric Coulomb Interactions

The *correct* Dirac Hamiltonian for electrons moving in an electromagnetic field when expressed in the Coulomb gauge is as follows:

$$\mathcal{H} = \int \psi^\dagger H \psi d^3\mathbf{r},$$

$$H = c\boldsymbol{\alpha} \cdot \mathbf{p} + mc^2\beta - e\boldsymbol{\alpha} \cdot \mathbf{A} + e\Phi, \quad (1)$$

$$div\mathbf{A} = 0 \quad \text{and} \quad -\nabla^2\Phi = 4\pi\rho \quad (2)$$

wherein  $\rho$  is the charge density and the Coulomb gauge potential  $\Phi$  obeys the Poisson equation yielding the Coulomb interaction

$$\Phi(\mathbf{r}, t) = \int \frac{\rho(\mathbf{r}', t) d^3\mathbf{r}'}{|\mathbf{r} - \mathbf{r}'|}. \quad (3)$$

To arrive at the incorrect Eq.(1) of the Hagelstein-Chaudhary manuscript[6], one merely needs to take our correct Eq.(1) and throw away (by erasure) the Coulomb interaction Eq.(3) in the Coulomb gauge.

Unfortunately, the whole Hagelstein-Chaudhary manuscript is invalidated by the *blunder* of leaving out  $\Phi$  in their very first equation. In the Hagelstein-Chaudhary model world in which the Coulomb gauge photon propagator does not contain  $\Phi$ , one would never find a Coulomb interaction by exchanging a photon between charges. This should come as no surprise since in the Hagelstein-Chaudhary model world Gauss' law no longer applies and every thing from Hydrogen atoms to condensed matter no longer exist. The full photon propagator in the Coulomb gauge contains a term corresponding to  $\Phi$  fluctuations as is written in any and all of the standard text books on quantum electrodynamics[16]. In such texts it is clearly explained that both longitudinal and transverse fields are required to compute mass renormalizations.

By keeping the small transverse electric field terms and arbitrarily throwing away the main charge density plasmon contribution, Hagelstein and Chaudhary are in gross error in evaluating the mass renormalization.

### 3 Magnetic Ampere Interactions

In the Hagelstein-Chaudhary manuscript[6], it was asserted that

“ ... it was proposed recently by Widom, Srivastava, and Larsen that a very large mass shift could be obtained in the strong electromagnetic fields associated with an exploding wire experiment. ...”

One might wonder why such an utterly false assertion was made. As any reader who consults our paper on exploding wires[7] can verify, mass renormalization *was not even mentioned*. Since we have been so blatantly misquoted by Hagelstein and Chaudhary, we will briefly review here the essence of what was *actually* discussed in our exploding wire work.

For non-relativistic moving charged particles, the effective Lagrangian was deduced by Darwin[17], and is presently discussed in the better electrodynamics textbooks[18, 19]. The Lagrangian has the usual form of a kinetic energy minus a potential energy

$$L = K - U,$$

$$U = \sum_{1 \leq a < b \leq N} \frac{e_a e_b}{r_{ab}},$$

$$K = \sum_{1 \leq a \leq N} \frac{1}{2} m_a |\mathbf{v}_a|^2 + \sum_{1 \leq a < b \leq N} \frac{e_a e_b}{2c^2 r_{ab}} (\mathbf{v}_a \cdot \mathbf{v}_b + (\mathbf{n}_{ab} \cdot \mathbf{v}_a)(\mathbf{n}_{ab} \cdot \mathbf{v}_b)), \quad (4)$$

wherein  $\mathbf{r}_{ab} = \mathbf{r}_a - \mathbf{r}_b$  and  $\mathbf{n}_{ab} = \mathbf{r}_{ab}/r_{ab}$ . The effective kinetic energy thus includes magnetic Ampere interactions between moving charges.

For the case of currents moving through thin wires, we employed a simple inductive form for the magnetic part of the kinetic energy. For a wire of length  $\Lambda$ , directed along a unit vector  $\mathbf{n}$  and having inductance  $L$ , the total kinetic energy is

$$K_N = \sum_{1 \leq a \leq N} \frac{1}{2} m_a |\mathbf{v}_a|^2 + \frac{1}{2} L \left( \frac{I}{c} \right)^2,$$

$$I = \frac{1}{\Lambda} \sum_{1 \leq a \leq N} e_a \mathbf{n} \cdot \mathbf{v}_a,$$

$$K_N = \sum_{1 \leq a \leq N} \frac{1}{2} m_a |\mathbf{v}_a|^2 + \frac{L}{2c^2 \Lambda^2} \sum_{a,b} e_a e_b \mathbf{n} \cdot \mathbf{v}_a \mathbf{n} \cdot \mathbf{v}_b. \quad (5)$$

The magnetic part of the kinetic energy thereby includes interaction terms between the  $a^{th}$  and  $b^{th}$  particles. The change in kinetic energy which accrues from destroying one charged particle is then

$$K_N - K_{N-1} = k,$$

$$k = \frac{1}{2} m |\mathbf{v}|^2 + \eta \left( \frac{eI}{c} \right) \frac{\mathbf{n} \cdot \mathbf{v}}{c}, \quad (6)$$

wherein the inductance per unit wire length is  $\eta = (L/\Lambda)$ . The second term on the right hand side of Eq.(6) represents the magnetic Ampere energy of a single electron moving in a wire with total electronic current  $I$ . A central result of our exploding wire work was written for the magnetic enhancement of the kinetic energy as

$$W_{\text{magnetic}} = -\eta m c^2 \left( \frac{I}{I_0} \right) \frac{v}{c}. \quad (7)$$

Many electrons acting cooperatively contribute energy  $W_{\text{magnetic}}$  to our weak interaction inverse beta transitions even though only one of those electrons is destroyed. The energy  $W_{\text{magnetic}}$  is again in the MeV range of nuclear physics for the many exploding wire experiments in which neutrons have been observed.

The above Ampere interaction energies being large, i.e. in the MeV range, were arbitrarily ignored by Hagelstein and Chaudhary who only chose to discuss small and totally negligible magnetic energies.

## 4 Conclusion

In the Coulomb gauge as with any other gauge, both longitudinal and transverse fields enter into the photon propagators and thus into mass renormalization. The Hagelstein-Chaudhary rejection of any and all Coulomb interactions is in complete disagreement with standard conventional electrodynamics. By contrast, our mass renormalization (for surface electrons on metal hydrides) which includes the large Coulomb interaction contribution still stands.

Hagelstein and Chaudhary have also falsely criticized our electron mass renormalization in exploding wire systems. This criticism is quite bizarre in that we never discussed mass renormalization in our exploding wire work. Hagelstein and Chaudhary have also ignored substantial Ampere interactions in favor of computing only totally negligible contributions.

In the light of these erroneous considerations of Hagelstein and Chaudhary, all our previous results are still valid.

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