Fundamental constants derived from two-dimensional harmonic oscillations in an electrically structured vacuum

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Abstract Based on a 1972 analysis of two-dimensional harmonic oscillations in an electrically structured vacuum, the fine-structure constant, magnetic moment of the proton and the g-factor of the electron are all derived theoretically and found to have values in perfect accord with measurement data. The analysis is based on newly discovered resonant interactions.

The experimental work of Nobel laureate Von Klitzing, which earned him the 1985 prize in physics, has highlighted the value of studying the quantum properties of an electron gas in which the oscillations are harmonic and confined to two dimensions. This has led to the new technique of precision measurement of the fine-structure constant, based on the quantum Hall phenomenon.

Earlier research has shown that analysis of the vacuum itself as a medium in which there are two-dimensional harmonious oscillations at the Compton electron frequency can account for Planck's radiation law and lead to a derivation of the fine-structure constant on pure theoretical grounds.

The analysis presupposes that the vacuum has properties analogous to those of a fluid-crystal medium, but governed by quantum electrodynamic (QED) transitions. Thus, charges e permeate a background continuum of uniform and opposite charge polarity. They form into a structure and tend to share the motion of coextensive material energy forms, but at the boundaries of microdomains the charges can mutually annihilate with the corresponding amount of charge in the continuum and shed energy which is transferred into a background of muon charge pairs. The latter form a migrant gas which can reconstitute the lattice structure and the continuum at boundaries where domains separate. The result is a vacuum medium exhibiting no linear momentum but able to provide a light reference frame which adapts to the motion of the laboratory-based observer and so accounts for the light-speed isotropy measurements of Michelson and Morley.

The explanation of Planck's radiation law is based on a feature of the two-dimensional harmonic oscillations of the charges e relative to the continuum charge. Storage of energy by increase of oscillation amplitude implies storage of a proportional amount of angular momentum. As angular momentum is conserved, the balance involves the counter-spin of a small cubic sub-unit of the lattice. This rotates at a frequency proportional to the energy quantum fed into the field and so perturbs the lattice in the manner formulated as Planck's radiation law and characterized by the Planck constant h.

The fundamental step I took in 1960[1] was of realizing that the charges e must be at zero potential relative to the continuum. Had they been at minimum potential, a negative energy state, then they would all be at rest and the vacuum would have no natural oscillation. It was an easy task to show that the charges e would have to be displaced in unison through a distance $2r$ relative to the centres of cubic cells of continuum charge of side d, neutralizing e, where r/d is approximately 0.3029.

Equally, it was quite straightforward to show that, if r were the Compton electron half-wavelength parameter $h/4\pi m_e c$, one could formulate:

$$\alpha^{-1} = hc/2\pi e^2 = (108\pi)(4r/3d) \tag{1}$$

This is the reciprocal of the fine-structure constant α and is known to be slightly greater than 137, from experiment. Hence the theory was well supported, as may be checked by putting $r/d = 0.3029$ in equation (1).

For a formal derivation of equation (1) see ref.2 or the more recent ref.3 which deduces it in the form:

$$\alpha^{-1} = hc/2\pi e^2 = (108\pi)(2/\beta)^{1/6} \tag{2}$$

where β is the energy ratio of the electron to that of the lattice charge e.

The major step was taken in 1972 when, in collaboration with Eagles, I established[4] that a resonance condition required β^3 to be an odd integer. The most appropriate value satisfying the non-negative but minimal potential energy condition was found to be 1,843, making r/d 0.302915878 and $hc/2\pi e^2 =$ 137.0359148.

Petley[5] has recently reviewed the theoretical determinations of the fine-structure constant and given due recognition to this method as defined by equation (2). It is valid at the level of 1 part per 10^6 when compared with the measured value.

However, Petley[6] in the same work draws attention to the fact that data available to the beginning of 1983 collectively yield a value of α^{-1} of 137.036004 to within 2.4 parts in 10^7. This gave me the impetus to look more closely at the theory discussed above to see whether there is any scope for modification.

The difficulty with such a proposal is that the analysis involving the resonance is so rigorous that I had little scope for correction and, indeed, hold the view that the value calculated is the true value for undisturbed vacuum conditions.

I have, however, long realized that the synchronizing constraints acting between lattice domains in relative motion will cause a displacement of the orbit of the lattice charges proportional to the relative velocity. This was applied to explain how the vacuum medium could develop magnetic fields when in a state of spin, leading to an explanation of the primary geomagnetic field. Wesson[7] acknowledged this saying "The origin of geomagnetism as a cosmological problem is in a confused state, however, the only really connected account being that of Aspden (1966)" (see ref.8).

In spite of this, the theory of the harmonic two-dimensional vacuum oscillations has remained dormant, physicists being reluctant to revive anything that might appear to be an aether. However, the constraining mechanism involved in the rotation of lattice structure in an enveloping lattice, the basis of this geomagnetic field induction, has a counterpart in linear motion. The Earth moves at a cosmic speed of about 390 km/s relative to isotropic background radiation. If the latter is isotropic in the enveloping lattice, then we know that the relative velocity v is 390 km/s and can work out how this affects the energy storage in the spins connecting with Planck's radiation law.

This motion is directed at about 12° to the plane in which the planets orbit the Sun and we will suppose that this plane is common to, or parallel with, the two-dimensional oscillations of the vacuum medium. Because cos 12° is 0.978 we can suppose that the in-plane component of v is about 380 km/s.

Now, the continuum charge and the lattice of e charges move in juxtaposition in orbits of radius r in the inertial frame when the vacuum is undisturbed by translational motion. This accounts for a $2r$ separation, noted above. If, however, they keep in register with charges having no translational motion, in spite of their own additional velocity v in their orbital planes, then their compounded orbital velocity will vary with angle in orbit and be $\Omega r + v\cos\theta$, where θ is changing harmonically. Ω is $2\pi m_e c^2/h$, the Compton angular frequency of the electron. From the value of r already given we see that Ωr is $c/2$, meaning that the charges e and the continuum have relative motion at the speed c of light, a not unnatural feature of the vacuum medium under study.

Now, to stay in register at their compounded velocities, the expression $\Omega r + v\cos\theta$ must be of the form $\Omega(r + \delta r\cos\theta)$, this being the tangential velocity in orbit, where δr is the planar displacement of the e charge orbit as a whole. Thus we can write:

$$\delta r/r = 2(v/c) \tag{3}$$

The energy associated with this orbital motion is proportional to $(2r + \delta r\cos\theta)^2$, so far as the electric displacement component is concerned. There is no displacement dependent kinetic energy because the motion in orbit about the displaced centre is at constant speed; translational linear motion does not affect either the angular momentum storage or the orbital kinetic energy. This means that since, normally, there is equipartition of energy between the displacement and kinetic energy storage, for the same change of angular momentum we have a change of field energy enhanced by the factor:

$$\frac{(2r)^2 + (2r + \delta r\cos\theta)^2}{(2r)^2 + (2r)^2} \tag{4}$$

which, for θ averaged over a complete 360° angle, is:

$$1 + (\delta r/r)^2/16 \tag{5}$$

From equation (3), this becomes $1 + (v/c)^2/4$. This is the factor by which $hc/2\pi e^2$ must be increased when measured in a space domain having a cosmic motion at the speed v. With v = 380 km/s, $(v/c)^2/4$ is 4.02×10^{-7}. This increases the value for $v = 0$ of 137.0359148 to 137.0359699, but bearing in mind that there is a small uncertainty in the measurement of the cosmic speed v and that it varies anyway by 30 km/s during the Earth's orbit around the Sun, this theoretical value will change by amounts commensurate with the current uncertainty in the measured value. The theory is, therefore, quite viable.

It is appropriate here to note that the basic lattice structure of the vacuum, meaning the dimensions of the lattice cells and the properties of the charge elements, is unaffected by translational motion. For this reason, the value derived in 1975 (see ref.9), for the proton/electron mass ratio remains as a firm result of the theory. This is:

$$m_p/m_e = \frac{3}{4\pi}(108\pi)^3/\gamma\beta^4 \tag{6}$$

where, as already noted, β^3 is 1843 and the factor γ is $\sqrt{(3/2)} - 1$.

Upon evaluation it may be verified that the proton/electron mass ratio thus predicted is 1,836.15232. This is in excellent accord with the measured value and has been assessed in relation to the latest measurement,[10] as well as a further comment on proton creation.[11]

This strengthens the case in support of the fine-structure constant evaluation discussed above.

We now extend the discussion to show that two other, very basic constants can be calculated with similar or better precision. We address first the question of the proton magnetic moment expressed in nuclear magnetons.

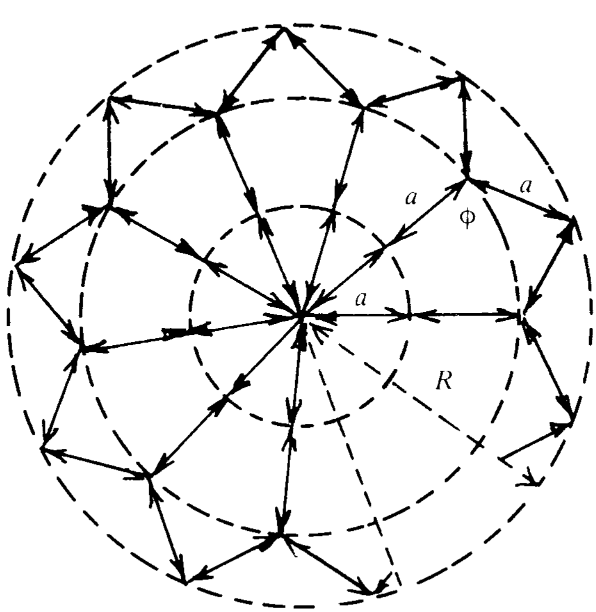

Figure 1 *Spherical charge form of radius a centrally located within two spherical field boundaries.*

In Figure 1, a spherical charge form of radius a is depicted centrally located within two spherical field boundaries. It is assumed that standing wave resonances exist in the field system thus portrayed, the half wavelength of which is the radius a. There are three spheres because one defines the charge and the charge is capable of limited movement within the field system relative to the two boundaries. The latter have a fixed radial spacing determined by the cavity resonance mode set up within the space between them. The limited motion of the charge really requires that the radius of the middle sphere is $2a$ so that the charge boundary tends to move about a mean position in which it lies at the nodes of the standing oscillations. The radius of the outer sphere is deemed to be as near as is feasible to a condition in which waves can travel around the cavity in a plane passing through the centre of the system with an angle of incidence at the middle sphere of 60°. For standing waves set up by two travelling waves moving in opposite directions this assures that the field energy pressure across the interface set by the middle sphere is the same on both faces.

The intrinsic magnetic moment of such a charge is that due to its confined oscillations as if its total inertia is that set by the energy bounded by the outer field cavity sphere. Because the angular momentum is carried by a mass reduced by $q^2/2Rc^2$, where R is the radius of this bounding sphere, q is the charge and c is the speed of light, we expect the magnetic moment to be anomalously increased by the usual factor 2 and by the factor:

$$M/(M - q^2/2Rc^2) \qquad (7)$$

Using the classical formula:

$$Mc^2 = 2q^2/3a \qquad (8)$$

which I have used in many fruitful particle analyses,[12] we can reduce equation (7) to:

$$2/(1 - 3a/4R) \qquad (9)$$

with the factor 2 now added.

The charge q and mass M are now eliminated, but we will be applying the formula to the proton and regarding it as a unitary charge, when reacting electrodynamically, or suppose that its quark constituents each individually have their own resonance wave system defined by equation (9). Our task is to calculate the ratio a/R; the value of a or R can be different for different quarks without affecting equation (9), provided the ratio a/R is determined.

As a preliminary guide, we know that a is the side of a triangle making an angle of approximately 120° with a side $2a$ and that R is the third side. Simple trigonometry then gives the value of R/a as $\surd 7$, based on the formula:

$$R^2 = (2a)^2 + a^2 - 2(2a)\cos\theta \qquad (10)$$

where θ is 120°. Putting this approximate value in equation (9) gives a factor 2.7912 as the magnetic moment of the charge compared with that it would have in large orbital motion, where all its mass shares the angular momentum. Thus, 2.7912 is an approximate estimation of the magnetic moment in nuclear magnetons if our particle system is the proton.

The measured value is 2.792846, so we are close. To take the analysis further we need to make sure that the standing wave resonance in the cavity between radii $2a$ and R is closed and does not involve an infinite number of revolutions around the system.

Let there be N reflections at the outer boundary in n complete revolutions. Given N and n we can then calculate θ and find R/a. For θ to be close to 120°, N/n must be close to 9.4208.

There are synchronizing constraints in this case determined by resonant interaction with electrons and muons in the surrounding lepton field. The wave path around the proton cavity involves a wavelength of $2Na$ and we now suppose that the radius a is 1/1,836 approximately of that of the electron charge. Thus, the wavelength of a disturbance making one revolution around the electron charge will be $2\pi(1,836)a$, which we take to be as close as possible to $2Na$ so that resonance is encouraged. Thus N is approximately 5,768.

The muon field involves a response at a frequency μ times that of the electron, where μ is the effective muon/electron mass ratio. Resonance implies that this is 205 or 207 (see also ref.13 for an independent analysis of muon properties). Thus, we expect that n will be a integral number z times μ.

The latter resonance is stronger than that of the electron and so we expect the two muon resonant modes to alternate, with the cavity resonance of the two states having minimal transitional effect on the radius R. This means that N/n must be as near equal as can be, consistent with a value of N in one case being near 5,768 and N/n being near 9.4208.

By working through the various possible values of N and n for the two muon modes, the optimum resonant state is found to be that for which N is 5,765 with n as 3 times 205 and N is 9,702 with n as 5 times 207. This gives a value of N/n of 9.373948 for both, to within 3.78 parts per 10^6. Note also that both ratios factorize down to lower values, 1,153/123 and 1,078/115, which enhances the resonance condition.

When this value of N/n is used to calculate θ we obtain 119.665213° and $(R/a)^2$ becomes 6.979724759. From equation (9) this gives a proton magnetic moment of 2.7928467 if we suppose that the two muon resonances have equal influence. If either resonance dominates this value can alter by up to 0.44 parts per 10^6.

However, the essential point is that this is extremely close to the measured value. Petley,[14] for example, quotes a 1983 measurement of this quantity in H_2O as 2.7927738 with a correction of 26.19 parts per 10^6 to convert to the free proton state. This gives 2.7928469, a value in excellent accord with that just calculated.

To advance this theoretical dissertation, I will now explore the scope for applying these same principles to the electron. In doing this we are treading on the territory of QED which already claims tremendous quantitative success. Indeed, according to Petley,[15] the $\frac{1}{2}g$ factor of the electron, as measured, is:

$$1.001159652200(40) \tag{11}$$

whereas the theoretical value from QED is:

$$1.001159652460 \tag{12}$$

which itself is uncertain because it relies on measured values of the fine-structure constant, the uncertainty being of the order of 100 parts per 10^{12}.

We will enter this field in the hope that we may discover some overriding resonance condition which can help to resolve the discrepancy between equations (11) and (12).

Again we consider a standing wave resonance involving three spheres, but in this case, as depicted in Figure 2, the resonance condition in the outer cavity is deemed to be a radial resonance at the Compton frequency. Thus the radial spacing between the middle and outer sphere is set by half the Compton electron wavelength. This is $3\pi/2\alpha$ times the electron charge radius determined by equation (8). Note that we are not dealing with normal electromagnetic waves when we consider these cavity field oscillations. They should be imagined as analogous to sound waves and are essentially oscillations of the energy in the field just as sound waves concern oscillation of gas.

The inner cavity resonance of the electron appears to have the simple symmetrical balanced form illustrated in Figure 2, which is closed in one revolution. Taking a as the radius of the electron charge, the radius of the middle sphere is simply $\sqrt{3}a$. We can, therefore, add this to $3\pi a/2\alpha$ to obtain the radius R and so deduce the electron g-factor from equation (9). However, a

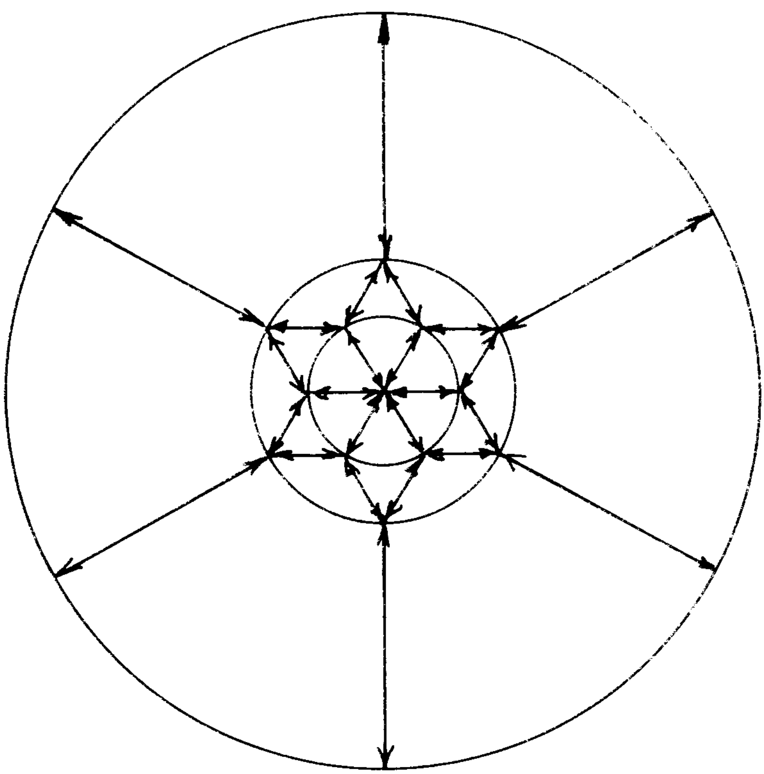

Figure 2 *Pattern of electron field cavity wave resonance.*

problem is that the waves in the outer cavity have a different frequency from those in the inner cavities and, ideally, to keep a regulated phase, which might be a consideration in understanding the nature of the charge polarity, this ratio should be an odd integer.

This point is of less consequence so far as the proton is concerned because the frequencies are so different that a constraint assuring this integer relationship would only modify the proton g-factor by about 2 parts per 10^7.

We therefore make the overriding condition of this odd integer relationship by saying that the actual half wavelength of the oscillations in the two inner field cavities is less than but as near as possible to the radius a. In other words, R is the half wavelength at the electron's Compton frequency incremented by the small factor $\sqrt{3}/N$, where N is the nearest odd integer above the value of $3\pi/2\alpha$.

From the fact that α^{-1} is just a little more than 137, $N = 647$ and:

$$g/2 = 1 + \frac{\alpha}{2\pi(1+\sqrt{3}/647)-\alpha} \tag{13}$$

from equation (9), where g denotes the electron g-factor.

We may tabulate the values of the fine-structure constant and the g-factor as related by equation (13) in Table 1.

Table 1 *Relationship between the fine-structure constant and the g-factor.*

α^{-1}	$g/2$
137.03597	1.001 159 652 365
137.03598	1.001 159 652 280
137.03599	1.001 159 652 195

Now, bearing in mind that the value given in equation (12) was based on a measurement of α^{-1} of 137.035 963,[15] it comes as quite a surprise to find that equation (13) has given what does appear to be virtually identical results. Therefore, both QED and this wave resonance theory would suggest that the measured electron g-factor in expression (11) corresponds to a value of α^{-1} close to 137.035 989.

Only further experimental work to measure the fine-structure constant can resolve the issues left open. If the value holds closer to the upper end of Table 1 then QED and the wave-resonance electron model discussed are both a little discrepant. Otherwise, the theory for the fine-structure constant might still be incomplete at the part in 10^7 level. Perhaps QED and the wave resonance combine at an intersection of their g-values to so determine a common value for the fine-structure constant. Alternatively, one might suppose that much of the analysis in both cases is dealing with the same field model, using different analytical techniques, and that the departure comes from the refinements in the model. Thus we see hadron corrections introduced in QED and contrasting with the dual resonance modes in the model just presented.

Equally, one can wonder how the QED theory of electron *g*-factor could be so close and yet be challenged. In this connection note that quirks of nature do occur in these theoretical calculations. Believers in magnetic monopoles could easily have adopted the formula provided by Wangsness[16] which gave the proton magnetic moment as 2.79253 nuclear magnetons but had dubious foundation in dimensional number theory. It did use equation (8), which itself is interesting. The more blatant mere numerical proposition is that of Lenz,[17] which merely presented the formula $6\pi^5 = 1{,}838.118$ for the proton/electron mass ratio, a theme which has encouraged Stanbury[18] to advance the numerology based on π to other fundamental constants, in the hope that something physical might connect with the method.

Such research based on numbers does tend to make analysis of fundamental constants appear as a disreputable pursuit, but this does not mean that the constants cannot yield their secrets. As we have seen, physical principles can lead to precise evaluation and QED techniques need not be the sole method of enquiry. The latter have failed completely to give account of the proton/electron mass ratio and the proton magnetic moment, causing researchers to turn in hope to quantum chromodynamics for their ultimate enlightenment.[19] However, hopefully, the reader will favour the techniques presented above.

References

1 Aspden, H., *The Theory of Gravitation*, Sabberton, Southampton (1960).
2 Aspden, H., *Physics Unified*, p.112, Sabberton, Southampton (1980).
3 Aspden, H., *Lett. Nuovo Cimento, 40*, 53 (1984).
4 Aspden, H., and Eagles, D.M., *Phys. Lett., 41A*, 423 (1972).
5 Petley, B.W., *The Fundamental Physical Constants and the Frontier of Measurement*, p.161, Adam Hilger, Bristol (1985).
6 Petley, B.W., *The Fundamental Physical Constants and the Frontier of Measurement*, p.309, Adam Hilger, Bristol (1985).
7 Wesson, P.S., *Q. Jl. R. Ast. Soc., 14*, 9 (1973).
8 Aspden, H., *The Theory of Gravitation*, 2nd Edn, Sabberton, Southampton (1966).
9 Aspden, H., and Eagles, D.M., *Nuovo Cimento, 30A*, 235 (1975).
10 Aspden, H., *Lett. Nuovo Cimento, 38*, 423 (1983).
11 Aspden, H., *Phys. Today, 37*, 15 (1984).
12 Aspden, H., *Speculat. Sci. Technol., 8*, 235 (1985).
13 Aspden, H., *Lett. Nuovo Cimento, 39*, 271 (1984).
14 Petley, B.W., *The Fundamental Physical Constants and the Frontier of Measurement'*, p.202 and 213, Adam Hilger, Bristol (1985).
15 Petley, B.W., *The Fundamental Physical Constants and the Frontier of Measurement*, p.187, Adam Hilger, Bristol (1985).
16 Wangsness, R.K., *Phys. Rev., 80*, 769 (1950).
17 Lenz, F., *Phys. Rev., 82*, 554 (1951).
18 Stanbury, P., *Speculat. Sci. Technol., 8*, 229 (1985).
19 Reinders, L.J., Rubinstein, H., and Yazaki, S., *Phys. Rep., 127(1)*, 1 (1985).