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Atomic Mass: Origin, Units and Constants

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Abstract

Absolute and relative atomic mass values are obtained in kg/atom, MeV, C, and u for the chemical elements. The results show that: (i) Absolute atomic mass value is, of course, given by the classical mass formula $m = h\vartheta/c^2$; however, rotational speed per radius ω/r correlates with strain τ on the element's intrinsic electromagnetic (e-m) transverse radiation to give the coefficient k whose value turns out to be atomic mass unit energy equivalent amu/eV = $k = \tau/(\omega/r)^{½}$. (ii) Each component of the wave-particle doublet plays unique roles in atomic mass phenomenology; these roles readily account for H atom's seeming fundamentality and preponderance of internal structures in virtually all particulate matter down to the electron. (iii) The mass constants amu/eV and amu/C are linear correlation coefficients of different dimensions of atomic units; the values are thus not specific to particular elements but obtainable from any element including the electron. (iv) The empirical expression e- = F/N_A is incorrect; theoretically, charge $q = m_rF = m_{abs}N_AF$. The error translates to values of N_A, m_e, and e/m_e that are twenty orders of magnitude lower than theoretical values, e.g., $e^-_{theor.} = 47.062$ C c.f. $e^-_{lit.} = 1.6022 \times 10^{-19}$ C. It is posited that the charge determinants ω and τ, might be suppressed or virtually nullified in an external e-m environment above some threshold voltage. (v) The error reflects also in all empirical E/c^2 values. A comparison of empirical and theoretical quantitative expressions for evaluating gravitational (gm) from electrostatic (E/c^2) atomic mass shows that the former redeems the inherent error to retrieve proximate gm from E/c^2 value. (vi) Given the current literature E/c^2 values, the electron waveform mass does converge with the photon's value, i.e., $m_{w(e)} \cong m_{photon}$. It is submitted, therefore, that particle physics has already struck matter's fundamental unit in the photon mass, maybe unknowingly for lack of litmus test.

Keywords: atomic mass, charge/mass ratio, electron charge, fundamental unit, photon-electron mass equivalence

1. Introduction

Inability to use the classical mass formula (CMF) $m = h\vartheta/c^2$ might be responsible for ceaseless formulations of alternative mass concepts, e.g., Nambu (1952); Jammer (1961); Eriksen (1976); Di Marzio (2011); Consiglio (2012) and Forsythe (2014). The CMF does pose a significant challenge; it demands a theory that links the atom with the specific ϑ value that defines atomic mass. With a background rooted in blackbody radiation developed originally from several contributors notably, Wein (1898), Planck (1900, 1901) and Einstein (1905a, 1905b), the CMF leaves no room for determining the mass-specific ϑ value. This singular challenge makes it impossible to work with or apply the equation to formulation of a mass concept that relates to observation. Attempts to develop alternatives are reducible to efforts to navigate around the challenge; indeed, it is not unlikely that the outcome of the 1927 5th Solvay Conference and subsequent Copenhagen Interpretation are explicable as attempts to by-pass the mass formula and chart alternative courses for progress. We now have evidence that, if understood in de Broglie (1923) context, the CMF presents with immense potentials for theoretical investigation of the atom once the element specific ϑ value was known. We have reported on procedures to evaluate ϑ for each element's wave and particulate forms (Obande, 2013, 2015a); with these values we carried out theoretical analysis of causalities of mass in the contexts of origin, units and the mass constants; the results are presented.

2. Method

After setting aside his metaphysics, we obtain each element's mass related ϑ value following the procedure outlined by Russell (1981). We then evaluate atomic mass with $m = h\vartheta/c^2$; the procedure, of course, yields absolute m_{abs} values. We generate relative atomic mass m_r from m_{abs} values with an incredibly simple arithmetic device described earlier. The procedure reveals that the atom (and indeed reality) comprises three orthogonal reference frames which we took liberty to call universes as they share common chemical periodicity and are governed by same laws of physics. It also makes a clear distinction between the atomic wave and particulate forms, each defined by its specific ϑ values. The values provided by Russell refer to atomic waveforms, we label these "absolute", designated "ϑ^*_{abs}" or simply "ϑ_w"; those that refer to particulate matter (comprising three variants analogous to Standard Model (SM)'s three mass generations) we label "molar" or more appropriately "de Broglie" radiation. We use the de Broglie radiation in a log-log plot of $h\vartheta$ vs. m to get the molar invariant radiation which we label "c^o" in contradistinction with vacuum radiation c. Equipped with values of atomic mass m_w, m_p; element-specific e-m field ϑ_w, ϑ_p; vacuum (i.e., waveform) transverse radiation c, and particulate matter's "de Broglie" radiation c^o, we analyze the atom with simple harmonic motion SHM formalism sticking strictly to correct use of relevant parameters for a given (wave or particulate) form. Details of these procedures have been reported (Obande, 2013, 2015a, 2015b, 2015c).

3. Results

The results are presented in Tables 1 and 2. Table 1 is a compilation of atomic mass values of the chemical elements in kg/atom; MeV; C and u; it facilitates comparison between conventional and Russell's chemical periodicities, it also highlights the precise electrical and gravimetric balance between the opposite charges (poles) that constitute the atom. Conventional electronic configuration is included in col. 16 to highlight its subjectivity. Table 2 provides an overview of the common identity of first element of Russell's periodicity, alberton Ab, and the electron e; the data are presented and discussed.

Table 1. Atomic mass of the wave and particulate forms in kg/atom., Mev, C and u and conventional electronic configuration

Atom	Rel.. m_r/u	Conv .Z_c	Russ.No.Z_R	e-mfreq .ϑ^*_w	Wavem$^*_w$kg/atom	Wavem$^*_w$/MeV	Partl.m$^*_{w(r)}$/C	Partl.Mass m^*_p/u	Partl.m^o_p/MeV	Partl.m_r/C $\tau_{(E)}/\tau_{(H)}$	Partl.m^o_p/MeV	Postivpole /C(p^+)	MolecularMass /u(p^++e^-)	Negativpole/C(e^-)	No. ofelectrons
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Ab	Invis	Invis	1	1	7.4E-51	7.6E-56	47.062	0.00049	0.455	0.00098	0.9097	0.00049	0.00098	0.00049	Unkn
Bl	Invis	Invis	2	2	1.5E-50	1.5E-55	94.124	0.00098	0.91	0.00195	1.8193	0.00098	0.00195	0.00098	Unkn
Bs	Invis	Invis	3	4	2.9E-50	3.1E-55	188.25	0.00195	1.819	0.00391	3.6386	0.00195	0.00391	0.00195	Unkn
A	Invis	Invis	4	8	5.9E-50	6.1E-55	376.5	0.00391	3.639	0.00781	7.2773	0.00391	0.00781	0.00391	Unkn
Rm	Invis	Invis	11	56	4.1E-49	4.3E-54	2635.5	0.02734	25.47	0.05469	50.941	0.02734	0.05469	0.02734	Unkn
Bt	Invis	Invis	12	64	4.7E-49	4.9E-54	3012	0.03125	29.11	0.0625	58.218	0.03125	0.0625	0.03125	Unkn
Mc	Invis	Invis	13	64	4.7E-49	4.9E-54	3012	0.03125	29.11	0.0625	58.218	0.03125	0.0625	0.03125	Unkn
G	Invis	Invis	20	512	3.8E-48	3.9E-53	24096	0.25	232.9	0.5	465.75	0.25	0.5	0.25	Unkn
Cg	Invis	Invis	21	512	3.8E-48	3.9E-53	24096	0.25	232.9	0.5	465.75	0.25	0.5	0.25	Unkn
D	Isot.	Isot.	22	1024	7.5E-48	7.8E-53	48191	0.5	465.7	1	931.49	0.5	1	0.5	(1)
T	Isot.	Isot.	23	1536	1.1E-47	1.2E-52	72287	0.75	698.6	1.5	1397.2	0.75	1.5	0.75	(1)
H	1.01	1	24	2048	1.5E-47	1.6E-52	96383	1	931.5	2	1863	1	1.99999	0.99999	1s1=1
He	4	2	28	4096	3E-47	3.1E-52	192766	2	1863	4	3726	2	3.99999	1.99999	1s2=2
C	12.0	6	32	16384	1.2E-46	1.3E-51	771064	8	7452	12.01	11187	6.005	12.01	6.00496	6
O	16.0	8	34	24576	1.8E-46	1.9E-51	1E+06	12	11178	15.99	14895	7.995	15.9899	7.99495	8
F	19.0	9	35	28672	2.1E-46	2.2E-51	1E+06	14	13041	18.99	17689	9.495	18.9899	9.49494	9
Ne	20.2	10	36	32768	2.4E-46	2.5E-51	2E+06	16	14904	20.18	18798	10.09	20.1799	10.0899	2p6 10
Na	23.0	11	37	32768	2.4E-46	2.5E-51	2E+06	16	14904	22.99	21415	11.495	22.9899	11.4949	11
Si	28.1	14	40	131072	9.7E-46	1E-50	6E+06	64	59616	28.09	26166	14.045	28.0899	14.0449	14
Cl	35.5	17	43	229376	1.7E-45	1.8E-50	1E+07	112	1E+05	35.45	33021	17.725	35.4499	17.7249	17
Ar	40.0	18	44	262144	1.9E-45	2E-50	1E+07	128	1E+05	39.95	37213	19.975	39.9499	19.9749	3p618
Fe	55.9	26	52	2E+06	1.5E-44	1.6E-49	1E+08	1024	1E+06	55.85	52024	27.925	55.8498	27.9248	26
I	127	53	79	6E+07	4.6E-43	4.7E-48	3E+09	30280.5	3E+07	126.91	118216	63.455	126.91	63.4546	53
Xe	131	54	80	7E+07	4.9E-43	5.1E-48	3E+09	32768	3E+07	131.29	122296	65.645	131.29	65.6446	5p6 54
Pt	195	78	104	8E+08	5.5E-42	5.7E-47	4E+10	366406	3E+08	195.08	181716	97.54	195.079	97.5394	78
Ac	227	89	115	3E+09	2.4E-41	2.5E-46	2E+11	1572864	1E+09	227.03	211477	113.515	227.029	113.514	89
U	238	92	118	5E+09	3.6E-41	3.7E-46	2E+11	2359296	2E+09	238.03	221724	119.015	238.029	119.014	6p6d1
Pu	244	94	120	6E+09	4.4E-41	4.5E-46	3E+11	2883584	3E+09	244	227285	122	243.999	121.999	94
Am	243	95	121	6E+09	4.7E-41	4.9E-46	3E+11	3145728	3E+09	243	226353	121.5	242.999	121.499	6p695

Table 2. Comparison of some empirical and calculated fundamental atomic values

S/No.	Ref. Frame	Atomic mass units	Form	Empirical Electron	Calculated Ab	Ratio Calc./Empirical
	1	2	3	4	5	6
1	Invisible	$m_{w(e)}$/ kg atom^{-1}	wave	9.10939E-31	7.3725E-51	8.09329E-21
2	Invisible	$m_{w(e)}$/MeV	wave	unknown	7.64917E-56	-
3	Invisible	e- (i.e., $m^*_{r(e)}$ /C g^{-1})	particle	1.60218E-19	47.06199941	2.93738E+20
4	Invisible	$m^*_{p(e)}$/u	particle	5.4858E-04	4.8828E-04	0.890082278
5	Invisible	$m^*_{p(e)}$ /MeV	particle	0.511	0.4548	0.890019569
			Mass Constants			
6	Invisible	Avogadro, N_A	particle	6.0221E+23	6.6230E+43	1.09978E+20
7	Invisible	amu_{wave}/eV	wave	1.07354E-09	1.0375E-05	9664.512152
8	Invisible	$amu_{particle}$/MeV	particle	931,494,096	931,494.00	0.001
9	Visible	e molecular mass $m_{p(e)}$/u:	particle	1.09723E-03	9.7656E-04	0.890082121
10	Visible	H molecular mass m_p/u:	particle	2.02000E+00	2.0000E+00	0.99009901
11	Invisible	Faraday Const. F/C mol^{-1}	particle	96,485.34	96,382.9748	0.998939096
12	Invisible	Charge/mass e/m_e (C/g)	particle	1.75882E+11	96,382.9748	5.47998E-07
13	Invisible	Proton/electron m_p/m_e	particle	1836.153701	2048	1.13498

4. Discussion

4.1 The Chemical Elements

Table 1 reveals that twenty three chemical elements precede hydrogen and three separate H from He. These elements fit remarkably well with the existing periodic arrangement with no gap between any two; they include three unknown or invisible noble gases with accompanying alkali metals, halogens and intervening elements. We took liberty also to propose non-conflicting abbreviations for the original names by which they are known. It turns out, as we shall see, that ignorance of these elements' existence has created untold challenges that keep particle physicists preoccupied employing the very best of human intellectual and material resources to resolve. Appreciation of existence and understanding of these invisible/unknown elements would positively affect the cause of theoretical and astro-physics. A major goal of this series is to highlight some of these hidden aspects of reality as best as we can with the hope to attract attention to the immense potentials for radical transformation of theoretical physics.

4.2 Gravitational (Inertial) Mass Unit

Space has always been associated with material vacuum (Kragh, 2002, 2012). Kragh (2014) credits Nernst's (1916) zero-point radiation, deducible from his original statement of thermodynamics' third law, with "the first recognition of an invariant [vacuum] energy density" and ranks as next to Nernst, Condon and Mack's (1930) submission that, "'When the electromagnetic field is treated … as an assemblage of independent harmonic oscillators, … this leads to the result that there is present in all space an infinite positive energy density. … It is infinite because there is supposed to be no upper limit to the frequencies of possible normal modes'". Thus, the atom's inertial mass must necessarily have two values, one for the vacuum (waveform) material and the other for the particulate atom; we determine these values.

4.1.1 Atomic Waveform Inertial Mass

It turns out that the original mass formula gives only inertial mass of the atomic waveform, i.e.,

$$m_{abs} \text{ (or } m_w)/\text{kg atom}^{-1} = h\vartheta/c^2 \quad (1)$$

Notably, m_w is an absolute quantity (m_{abs}), it does not depend on another.

4.1.2 Particulate Atom's Relative Mass

Relative atomic mass is, of course, a dependent quantity, it relates an element's absolute atomic mass to H atom's value. The definition is, however, quantitatively not limited to mass *per se* but includes values of the rotational determinants, ϑ; ω; and τ, thus we have

$$m_r(\text{or } m_p)/u = m_{abs(E)}/m_{abs(H)} = \vartheta_{w(E)}/\vartheta_{w(H)} = \omega_{w(E)}/\omega_{w(H)} = \tau_{w(E)}/\tau_{w(H)} \quad (2)$$

where ϑ/Hz is definitive frequency of the atomic intrinsic e-m oscillation; ω/rad s^{-1}, rotational speed and τ is longitudinal strain or tension on the e-m transverse radiation. Normally, the number of particles in the molar unit obtains also as ratio of relative to absolute atomic mass, in other words,

$$N_A/u = m^*_r/m^*_{abs} = 1/m_{w(H)} = 1/\vartheta_{w(H)} \quad (3)$$

where the asterisk denotes "absolute" ref. frame (Obande, 2013). N_A evaluates also from radiation equivalent of particulate matter, i.e.,

$$N_A/u = m_r/m^*_{abs} = (c/c^o)^2\vartheta_p/\vartheta_w \quad (4)$$

Notably, Equation (4) evaluates Avogadro Constant without reference to H, it simply defines N_A as ratio of atomic particulate to waveform mass.

Observe that Equations (1) to (4), describe much of the details of matter's construction: (1) refers to formation of the element's waveform atomic mass from the primitive e-m wave packet; (2) describes formation of relative mass of the *invisible* particulate atom from waveform parametric interactions; (3) counts the number of particles in the *invisible* molar unit in terms of only H atom's wave packets and (4) counts the number of particles in the *visible* molar unit in terms of a slightly more complex parametric combination of e-m radiations. Atomic mass values of invisible (particulate) molar units described in Equation (3) are listed in col. 8 Table 1; notably, they are identifiable with literature's *Dark Matter* (Obande, 2013, 2015a). Invisible particulate matter constitutes two invisible material reference frames coexisting with our visible frame. We note the remarkable correspondence between the classical three "particulate matter's reference frames" and SM's three particle generations (Francis, 2015). Notably, the classical ref. frames and quantum particle generations are similarly differentiated by *only* atomic mass values, see post He mass values in Table 1, cols. 9 and 11.

Equations (3) and (4) inform that although they give the same N_A value, significant structural difference(s) exists between the visible macrocosmic particulate atom's molar unit and its invisible microcosmic analogue. In other words, in Table 1, the invisible molar unit of col. 8 or 10 is structurally different from its visible analogue of col. 12. We return to the subject in Section 4.4.

4.2 Unit Inertial Mass

Notice the difference between the more elaborate "Natural Periodicity" (NP) of the chemical elements described by Russell and Mendeleev's Conventional Periodicity (CP), both are juxtaposed in Table 1 for comparison.

4.2.1Atomic Waveform

The NP begins with alberton Ab, an unknown/invisible element that readily identifies with the electron e (see Table 2); it starts the periodicity with the e-m field $\vartheta_{w(e)} = 1.0$ Hz, likewise americium Am ends the periodicity with $\vartheta_{w(Am)} = 6.442450944 \times 10^9$ Hz (Obande, 2013, 2015a); values of these parameters must be accurate to a minimum nine decimal places wherever possible for best results. In the absence of these values Nernst (1916) made an arbitrary estimate of the upper bound $\vartheta_m = 10^{20}$ Hz while Condon and Mack (1930) conjectured that there might be no upper bound ϑ_m. Indeed, to date literature is silent on the subject; here, the NP gives $\vartheta_m = \vartheta_{Am} = 6.442450944 \times 10^9$ Hz; notably, ϑ_m is not defined in CP as researchers strive continually to synthesize new trans-lawrencium elements.

With $m_{w(e)} = h/c^2 = 7.3725 \times 10^{-51}$ kg/atom, the electron waveform is identified with universal unit of mass, its vacuum field (i.e., c^2) multiples give Planck Constant and universal energy unit (Obande, 2015a).

4.2.2 Atomic Particulate Form

Equation (2) gives, for the particulate electron, $m_{p(e)} = m_{w(e)}/m_{w(H)} = 7.372496680 \times 10^{-51}/1.509887320 \times 10^{-47} = 4.8828125 \times 10^{-4}$ u in line with CODATA 2014 (empirical value) $m_e = 5.485799091 \times 10^{-4}$ u. Of course, for H we have $m_{w(H)}/m_{w(H)} = m_{p(H)} = 1.0$ u, it thus identifies H with particulate matter's fundamental unit, see Table 1, cols. 3, 9, 11, 13 and 15, 16. Thus, the analysis presents two fundamental units of matter: (i) an "absolute" fundamental – the electron waveform $m_{w(e)} = 7.3725 \times 10^{-51}$ kg/atom and (ii) a "relative" fundamental unit of particulate matter – molar hydrogen atom $m_{p(H)} = 1.0$ u.

4.3 Avogadro Constant (Loschmidt Number)

Equations (3) and (4) give the same theoretical value $N_{A(theor.)}$ (or L) = 6.623×10^{43} (Obande, 2015a), notably, it is twenty orders of magnitude higher than the empirical $N_{A(empir.)} = 6.022140857 \times 10^{23}$ (CODATA 2014), the subject is addressed later.

4.4 Origin of Mass and Electrostatic Mass Units

4.4.1 Origin of Mass

Atomic mass originates from the parametric combination,

$$\tau = k(\omega/r)^{½} \tag{5}$$

where τ is longitudinal strain or tension on the e-m transverse oscillation, ω rotational frequency and r is radius of the rotating e-m envelope. A log-log plot of τ vs. ω/r yields the waveform coefficient k = 1.0372055868 x 10^{-5}; calculated value = 1.037528416 x 10^{-5} (rad s^{-1} $m^{-1})^{½}$. Similar correlation for the particulate atom gives 9.311078755 x 10^5 and calculated value = 931,494 (rad s^{-1} $m^{-1})^{½}$ see Table 2, row 7; in other words,

$$amu/eV = k = \tau/(\omega/r)^{½} \tag{6}$$

The particulate atom's k = 931,494 MeV would seem in line with CODATA 2014 $amu_{particle}$/MeV = 931.4940954. The waveform value is, however, four orders of magnitude higher than CODATA's eV = 1.07354411 x 10^{-9} u. Literature's assumption that amu/eV is not a physical constant of nature but an electron volt–atomic mass unit "relationship" leads to the erroneous value eV/u = 1/($amu_{particle}$/MeV) = 1/931.4940954 = 1.07354411 x 10^{-9} which is four orders of magnitude lower than the theoretical value. Notably, these results question the magnitude of literature amu/MeV; however, that is not a subject for present concern. Observe that units of k are indicative of spin quantum number, i.e., $m_s \equiv$ (rad $s^{-1}m^{-1})^{½}$. The fact that the waveform registers with an amu/eV value re-affirms our position that the vacuum comprises e-m waveforms of the chemical elements equivalent to their macrocosmic visible presence.

While the value $amu_{particle}$ = 931.4940 MeV registers with H atom, amu_{wave} = 1.037528416 x 10^{-5} eV does not register with any element indicating that elemental waveforms do not exist individually but bind together to form a single cosmic e-m superfluid with common amu value. However, although inseparable from the bunch, the elemental waveform retains its element specific properties (Obande, 2015b, 2015c).

4.4.2 Electrostatic Charge

Electric potential/electrostatic charge atomic mass values register in Table 1 cols. 7 and 8 for the atomic waveform and 10 and 12 for particulate atom. Values in col. 7 result from simple multiplication of m_{abs} with the waveform amu, i.e.,

$$m_w/MeV = m_w/kg\ atom^{-1} * amu_{wave}/eV \tag{7}$$

the values vary from electron's 7.64917480 x 10^{-56} to americium's 4.927943342 x 10^{-46} MeV. Notably, these (absolute) values are a far cry from literature E/c^2 values. Briefly, we reason that inseparability of the wave and particulate components of the doublet might make separate determination of the waveform component practically impossible when experimenting with tangible matter. Observe that, in general, the electron's (i.e., the first) is *always* ten orders of magnitude lower than americium's (i.e., the last) value.

Column 8 lists values for the waveform electrostatic charge equivalent of atomic mass given by

$$m^*_{w(r)}/C = (m_w/kg\ atom^{-1})/(m_{w(H)}/MeV) \equiv q_{w(r)}/C \tag{8}$$

where $m_{w(H)}$ = 1.566551 x 10^{-44} MeV. Notably, the quantity $m^*_{w(r)}$/C is waveform *relative atomic mass* electrostatic charge equivalent $q_{w(r)}$; in other words, it is an *invisible* particulate molar quantity, the defining parameters on the right hand side (rhs) are indicative. The subject presents an interesting case study that cannot be accommodated within this report; briefly, $m^*_{w(r)}$/C (i.e., $q_{w(r)}$) refers to invisible microcosmic particulate material precursors of visible material forms. For the electron, Equation (8) gives (7.3725 x 10^{-51})/(1.566551 x 10^{-52}) = 47.06198521C/g, that is, particulate e's charge value; it is the electrostatic charge unit and gives q/m_p = 47.06198521/4.8828125 x 10^{-4} = 96,382.94571C/g, the Faraday Constant F. Notably, evaluation of F from e further re-affirms several earlier indications of elemental electron (Obande, 2013, 2015a). Observe that H atom registers in Table 1 with its familiar value $m_{p(H)}$ = $amu_{particle}$ = 96,382.96383 C/g in line with CODATA 2014 F = 96,485.3251 C/mol; thus, we can write

$$F = q_{w(r)}/m_r \tag{9}$$

Equation (9) states that particulate matter forms from division of the waveform charge value $q_{w(r)}$ by a universal charge quantum - the Faraday Constant F, i.e., H atom's mass equivalent of charge. Notably, (9) is likely the first quantitative expression of Einstein's mass – energy equivalence. Quite unexpectedly, it provides an invaluable device whereby elemental status of a sub-atomic particle may be verified by matching its q/F value with that of a sub-H element in Table 1. Indeed, the equation evaluates for D and T, m_r = q/F = 0.5 and 0.75 respectively (cols.

9, 11 and 13) and presents these elements as full-fledged elements with molecular mass values $2m_r$ = 1.0 u, 1.5 u in line with H = 2.0 u (col. 14).

Columns 10 and 12 list the particulate atom's mass unit - energy (eV) equivalent obtainable with

$$m_p/\text{MeV} = (\text{amu}_{\text{particle}}/\text{MeV})*(m^*_p/u) \equiv q_p/\text{MeV} \quad (10)$$

For particulate electron (10) gives $m_{e(p)}$ = 931.494 MeV/u*4.8828125 x 10^{-4} u = 0.454831054 MeV in line with literature's 0.511 MeV; H atom, of course, gives 931.494*1.0 = 931.494 MeV.

4.5 Atomic Mass Constant and Identification of the Electron with First Element

Values of the particulate atom's mass constants amu/C and amu/eV respectively obtainable with Equations (8) and (10) are presented in Table 2; the equations reveal that these constants are not specific to a given element but obtainable from correlations of relevant mass units of any element including, as we find here, the electron. Notably, similarity of empirical and theoretical values of: m_r (i.e., $m^*_{p(e)}/u$); $m^*_{p(e)}$/MeV; $\text{amu}_{\text{particle}}$/MeV; and the Faraday Constant F identifies Ab with the electron e. In general, entries in Table 2 reveal that: (i) Apart from molecular mass values (rows 9 and 10), all others refer to invisible forms. This might partly explain the fact that non-molecular particulate forms such as ions and radicals are unstable in the visible universe; in other words, macrocosmic particulate forms are stable and visible only as oppositely charged couples or molecules. We have reason to suspect that more detailed examination might point to the possibility of a geometric perspective for this effect. (ii) The correct unit of absolute atomic mass is kg/atom, e.g., m_e = 9.10938356 x 10^{-31} kg/atom, not u or kg/mol. which are molar units. (iii) Theoretical and empirical values of: m_e , ($m_{w(e)}$); e- ($m_{r(e)}$/C); and N_A differ by twenty orders of magnitude (col. 6) attributable to systemic error in empirical procedure for measuring e- value.

4.5.1 Electron Charge

The empirical expression e- = q_e = F/N_A is revealed incorrect, it lacks theoretical basis. Equations (4) and (9) combine to give $m_r = q/F = m_{abs}N_A$, or $q = m_{abs}N_AF$ which, for the electron, gives e- = 7.3725 10^{-48}*6.623 x 10^{43}*9.638396 x 10^4 = 47.062 C/g in line with Equation (8); the value differs significantly from empirical e- = 1.0622 x 10^{-19} C/g; the error replicates in values of m_e and N_A. Now, empirical e-, e-/m_e and N_A values result from pioneering investigations by some of the most brilliant physicists of all time; it has never been mentioned, nor indeed suspected, that these values could, by any stretch of the imagination, be in error. If current theoretical analyses are correct, as indicated here with repeated alternative procedures, some fundamental systemic error must be eluding the physical community over the centuries. The original papers reporting these values are of exceptional quality, therefore, there is no question regarding data validity. Indeed, Millikan's paper cites several preceding reports on e- value obtained from different sources all of which fall within similar orders of magnitude. We must, therefore, conclude that the substantial divergence of empirical e- and N_A from theoretical values can come only from systemic error. We reason that above certain e-m field threshold voltage, the intrinsic rotational parametric interaction $\tau/(\omega/r)$ which gives rise to the atom's charge and inertial mass is drastically diminished or indeed nullified rendering the atom "electrically" massless. Since physics still relies on procedures similar in principle to Thomson's, a thorough investigation of the subject would be crucially important to reliability of empirical E/c^2 values.

4.5.2 Proton/Electron Mass Ratio

Empirically, m_p/m_e = 1.00727647/5.48579909 x 10^{-4} = 1836.1527; however, theoretically we get = 1.0/4.882813 x 10^{-4} = 2048 Hz, (Table 2, row 13 cols. 4 and 5); in other words, the proton is precisely 2048 times heavier than electron. More importantly, the ratio should, in principle, be dimensionless; theoretical analysis however reveals that it retrieves H atom's intrinsic e-m waveform field $\vartheta_{w(H)}$ = 2048 Hz (Obande, 2015a). It follows therefore that generally,

$$q_{(E)}/q_{(e)} = m_{r(E)}/m_{r(e)} = \vartheta_{p(E)}\ \text{Hz} \quad (11)$$

Since ϑ_e = 1.0 Hz and m_r = q/F Equation (11) says that value of an element's charge quantum or molar mass relates to electron's value to retrieve the element's de Broglie e-m field ϑ_p. Notably, (11) provides a much easier ϑp evaluation procedure than reported earlier (Obande, 2013, 2015a).

4.5.3 Possibility for Convergence of Quantum and Classical Mechanics

Standard Model (SM)'s recognition of dual existence of matter as doublet wave (boson) and particle (fermion) is perhaps the most liberating achievement of modern physical research. The value $m_{w(e)}$ = 7.3725 x 10^{-51} identifies the electron waveform with the photon's upper bound mass $m_{\text{photon}} \leq 10^{-14}$ eV/c^2 (Adelberger et al., 2007) and ≤ 10^{-18} eV/c^2 (Williams et al., 1971, and Amsler et al., 2008). Empirically, inertial mass retrieves from E/c^2 value with the expression

$$m_w/\text{kg atom}^{-1} = (Ec^{-2}*\text{eV/amu})/N_{A(empir.)} = E/c^2*1.7827 \times 10^{-33} \quad (12a)$$

while theoretically, we have

$$m_w/\text{kg atom}^{-1} = (E\ c^{-2}/\text{eV amu}^{-1})/N_{A(theor.)} = E/c^2*1.4553 \times 10^{-38} \quad (12b)$$

For $E/c^2 \sim 10^{-14}$ and 10^{-18} eV; (12a) yields $m_{w(e)} \sim 10^{-47}$ and $\sim 10^{-51}$ kg and (12b) gives $m_{w(e)} \sim 10^{-52}$ and $\sim 10^{-56}$ kg respectively. That is, whichever method used, the results agree with an upper bound $m_{photon} \sim 10^{-14}$ eV or $\sim 10^{-18}$ eV. Given the theoretical procedure, the values obtained with Equation (12a) are fortuitous since it utilizes incorrect values of N_A and amu/eV. The photon is, nonetheless, positively identified with electron waveform in line with earlier reports (Obande 2013, 2015a); more importantly, a historic convergence of SM and classical pictures of the wave-particle doublet is indicated.

4.6 Electronic Configuration and the Quest for Matter's Fundamental Unit

4.6.1 Electronic Configuration

Table 1, col. 4 reveals twenty three elements preceding H; that is, despite its indispensability, assignment of $1s^1$ electronic configuration to H is arbitrary. Prout (1815) provides ample empirical evidence to indicate existence of a fundamental particulate unit – the hydrogen atom. The physical society sadly paid little attention since the report supposedly addressed chemistry. Indeed, much later, Thomson (1897) sealed the case when he openly rejected the idea on the then unquestionable results of his cathode ray experiments, and another rare opportunity (after Faraday) was lost for physics to appreciate nuclear structure from the chemical perspective. The present results reveal that the sheer descriptive power of conventional electronic configuration stems from denomination of the particulate atom's inertial mass in H atom's value. Physics is yet to appreciate the molar nature, its formation process, presumably in stellar nucleosynthesis, and its bearing on nuclear structure. As a result of the process, every tangible matter, down to the photon, presents with an elaborate internal structure comprising preceding elements' atomic structures. The SM describes constituents of the atom's internal structure with exotic tags, however, we anticipate that if eventually the much needed convergence of classical and quantum world views is realized, all data gathered from experimental and theoretical physics will come in handy for mathematically explicit and observationally descriptive classical-quantum atomic theory.

4.6.2 Search for Matter's Fundamental Unit

We are unaware of an existing yardstick or litmus test for identifying the fundamental unit when it is struck; however, given the results of series of investigations, we remain confident that the electron waveform is nature's "absolute" fundamental unit and H atom is fundamental to particulate matter. The molar form is so fundamental to tangible matter that H atom, electron, photon and virtually all particles present with elaborate internal structures (Street, 1937; Ball, 2000; Maris, 2000; Vlaicu, 2010; Di Casola, 2015); indeed, the photon's structure is a lot more involved. With this overview and existence of 23 *elements* (not elementary particles) embedded within the molar fundamental unit - the H atom, we may appreciate the unthinkable awesomeness of the task experimental atomic physics sets out to achieve. With $N_A = 6.623 \times 10^{43}$ particles, one mole H contains N_A atoms, each of which in turn contains another N_A atoms of each of the preceding elements *ad sequela* up to the first element! Given this convoluted picture of the particulate unit, getting to the fundamental by sequentially peeling (knocking) off preceding elements would require available energy of the entire universe and that is, if and only if, successive elements peeled off neatly in layers like onion peel. With this reality, the search by mechanical means for matter's fundamental unit might hardly ever lead to a conclusive end, especially if no "litmus" test exists for the unit. We see the commitment of some of the best of human intellect and inestimable resources to the search as no more than fostering an inordinately expensive interminable academic curiosity, in itself a necessary, often not unprofitable, venture. However, a little more attention to alternative theoretical procedures would be far less expensive, less risky, more environmentally friendly, and would, definitely, offer higher returns on investment in unfolding the details of nature's intricate webs. We submit with confidence that particle physics already struck nature's fundamental unit in the photon mass value; it might not be evident if it lacked a litmus test.

Subject to independent verification, we present Table 1 as a particle physics reference resource on which basis we submit that a particle registering with $E/c^2 < 931.4940954$ MeV cannot be correctly described as "elementary" but a "sub-hydrogen" entity. Depending on how the atom fractures when smashed, the fragment may be an energy packet corresponding to an unknown "sub-hydrogen" element, in which case its inertial mass would fall within the values listed in Table 1 for sub-H (invisible) elements. Likewise, an energy packet, resulting from atom smashing or other mechanical means, having inertial mass value $E/c^2 > 931.4940954$ MeV is a supra-H particle. If the value falls within those listed beyond H in Table 1 (col.10) the particle is an element otherwise it is, undoubtedly, an energy packet fragment with mass unrelatable to any element; yet, it should come as no surprise if the fragment presented with internal structure at higher energy environments.

Summary and conclusion

i. Absolute and relative atomic mass are evaluated in kg/atom^{-1}; MeV; C and u for elements of the chemical periodicity; the procedure reveals that in addition to ϑ, other rotational properties such as ω and τ relate to hydrogen's to also give relative atomic mass values.

ii. The procedure affords a more comprehensive picture of reality as it easily illuminates: (a) mass-determinant roles of each component of the wave-particle doublet (duality); (b) H atom's seeming fundamentality despite an elaborate internal structure, and (c) preponderance of internal structures in every accessible energy packet down to the photon.

iii. The particulate atom's (relative) mass is electrostatic charge fraction or whole number multiple of H atom's value; it becomes stable and visible in the visible universe only as oppositely charged couples or molecules. It is hoped that future examination of the subject would turn up deeper physics of reality.

iv. Every element's atomic waveform is reduced to H's value to produce the particulate or molar form. The process accounts for H's first position in conventional periodicity and makes H the "molar" fundamental. Thus, all particulate energy packets, including e, H and the twenty three unknown sub-H elements (they are not *elementary particles*) present with elaborate internal structures that convolute the "absolute" fundamental.

v. With the support of quantitative expressions, rotational motion or spin is shown to effect electrostatics and inertial mass. The procedure identifies spin quantum number $m_s = \pm½$ with exponent of coefficient of linear correlation of parameters that define inertial mass and fix its value.

vi. Atomic mass unit energy equivalents amu/C and amu/MeV are quantitatively defined and identified with universal constants whose values are not specific to but obtainable from every element including the electron. Furthermore, CODATA's electron volt–atomic mass unit "relationship" turns out not a "relationship" but the waveform atomic mass unit equivalent of charge amu/eV defined with the same parametric interaction $\tau/(\omega/r)$ that defines particulate atom's amu/MeV. Being simply inverse amu/MeV, CODATA's eV = 1.0735441105 x 10^{-9} u is widely in error of the theoretical waveform value $amu_{(wave)}$ = 1.037528416 x 10^{-5} eV.

vii. The empirical expression e- = F/N_A is in error. Theoretical analysis reveals the general relationship $q = m_rF = m_{abs}N_AF$ where q is charge equivalent of relative atomic mass m_r, and F is the Faraday Constant. This simple expression is possibly the first quantitative demonstration of Einstein's mass-energy equivalence.

viii. Since q/m = F, literature's e-/m_e = 1.7588458 x 10^{11} C/kg is sadly wrong. Divergence of empirical values of N_A; m_e; and e- from theoretical values by twenty orders of magnitude is traceable to same error. It is posited that an external e-m field above some threshold voltage drastically suppresses, or indeed nullifies intrinsic atomic spin that creates charge; it accounts for the significant margin between theoretical e- = 47.062 C and empirical 1.602176621 x 10^{-19} C.

ix. A comparison of mass values identifies classical electron waveform with the photon, $m_{w(e)} \cong m_{(photon)}$, suggesting convergence of Standard Model (SM) and Classical pictures of the atom.

In conclusion, we observe that, from classical perspective, the SM seems built on recognition that the atom consists of irreducible wave-particle doublets of diverse forms; these it identifies with the family tags "bosons" and "fermions". In this respect, the classical procedure shares a common platform with the SM on nature of matter's irreducible constituents. However, it would seem the SM lacks a yardstick for identifying the (absolute) fundamental unit when it presents in the plasmic cauldron; we, therefore, place on record that the photon is matter's absolute fundamental unit; experimental and theoretical evaluation of its mass through the Higgs mechanism implies that particle physics has struck matter's fundamental unit. It must be noted, however, that due to inseparability of the wave and particle components of the doublet, and molar nature of the particulate atom, it should be no surprise if the photon registered with internal structures at higher energy levels. The energy input does not go into unleashing any new elemental constituents but overcoming resistance of the universal invariant unit mass bosonic binding universal acceleration g_{boson}/kg = 7.943 10^{59} m s^{-2} (Obande, 2015b) which opposes disruption of the waveform elemental e-m rotors that bind matter together. Higher energy levels are bound to unleash even more exotic packets, these could be elemental waveforms occluded in the electron's to constitute the vacuum material, fragments or composites, i.e., "glues" which are likely to manifest with inordinately high energy profiles unrelatable to atomic mass values.

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