Self-interaction mass formula that relates all leptons and quarks to the electron

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Abstract. – An accurate empirical self-interaction mass formula has been obtained for all twelve leptons and quarks, in which the baryon number B and the charge number Q enter as eigenvalue surrogates for the strong and the electromagnetic self-interactions. All lepton and quark masses appear directly related to the electron mass.
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Recently very detailed high-precision calculations have established the masses of the up and down quarks and as

$$m_u = 2.01\,(10)\ \text{MeV} \qquad\qquad m_d = 4.77\,(15)\ \text{MeV} \tag{1}$$

at the most appropriate 2 GeV energy-scale in the $\overline{\text{MS}}$ renormalization scheme [1]. Thus the masses of the first-generation leptons and quarks are given by the *self-interaction mass formula*

$$m = m_e \langle (8\mathbf{B} – \mathbf{Q})^2 \rangle \tag{2}$$

in which m_e is the experimental mass of the electron (taken as empirical input) and **B**, **Q** are commuting quantum operators that give the baryon number $B \equiv \langle \mathbf{B} \rangle$ (eigenvalue surrogate for the strong interaction) and the charge number $Q \equiv \langle \mathbf{Q} \rangle$ (eigenvalue surrogate for the electromagnetic interaction), with $\langle \mathbf{BQ} \rangle = BQ$, $\langle \mathbf{B}^2 \rangle = B^2$, and $\langle \mathbf{Q}^2 \rangle = Q^2 + \varepsilon$ where $\varepsilon = 2.97 \times 10^{-11}$ derives from the virtual charge-distribution around a neutrino due to

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electroweak closed-loop processes [2, 3]. Hence from (2) we obtain

$$m_{\nu_1} = \varepsilon m_e = 1.52 \times 10^{-5}\,\text{eV}$$

$$m_e = 0.510999\ \text{MeV} \qquad (3)$$

$$m_u = 2.044\ \text{MeV}$$

$$m_d = 4.599\ \text{MeV}$$

Comparing (1) and (3), we see that the empirical formula (2) yields accurate values for the u and d masses. Lepton and quark self-interaction mass given by (2) for the first generation has an absolute physical character, energy-scale independent like pole mass [4] but with a physical meaning that does not involve perturbation-renormalization theory (†).

The self-interaction mass formula (2) can be generalized for the second and third generations. Let $\xi = \xi^3 = (0, -1, +1)$ be the *generation quantum number*, with $\xi = 0$ for the first, $\xi = -1$ for the second, and $\xi = +1$ for the third. By employing data-fitting techniques [6,7], we find

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(†) Existence of a Higgs boson to break the electroweak symmetry and engender the zero-mass photon and the massive $W^{\pm}$ and Z° bosons is of course likely. However, it is uncertain whether the Higgs should also generate lepton and quark masses through a hierarchy of Yukawa couplings [5]. While the four fundamental bosons H, γ, $W^{\pm}$ and Z° most probably relate to each other, the twelve fundamental fermions appear to relate through the self-interactions mass formula (4). The lepton and quark mass values subsequently enter the standard model Lagrangian as pre-established input, with the mixing of quark states, as well as the mixing of neutrino states, viewed to be a standard model field-interaction phenomenon.

$$m = m_e \langle (n\mathbf{B}-\mathbf{Q})^2 \rangle \, 3^{|\xi|} (4.1)^{4|\xi|+\xi} \quad (4)$$

in which the even-integer valued coefficient of **B** is

$$n = 2^{3+(P+\frac{1}{2})\xi+(2P-\frac{3}{2})|\xi|} \, 3^{P(|\xi|-\xi)/2} \quad (5)$$

Appearing in (5) is the *projection quantum number* $P = P^2 \equiv |B+Q|$ which equals zero for $|Q| = 0$ or $\frac{1}{3}$ and equals unity for $|Q| = \frac{2}{3}$ or 1. Hence (5) reduces to

$$n = 2^{3+(\xi-3|\xi|)/2} \qquad \text{for} \quad P=0$$

$$n = 2^{3+(3\xi+|\xi|)/2} \, 3^{(|\xi|-\xi)/2} \qquad \text{for} \quad P=1 \quad (6)$$

In the final term in (4), the base factor (4.1) = (41/10) appears for the mass scaling of the three generations, as in earlier empirical investigations that were restricted to the charged-leptons [8,9]. The logical simplicity and quantum-theoretic character of the mass formula (4) are clearly evident, with all lepton and quark masses manifestly related to that of the electron.

The quantum numbers for leptons and quarks appear with their self-interaction masses (4) in the TABLE. The overall agreement with the experimental masses [10,11] is quite striking. In particular, we have the fractional deviations $\delta m_\mu / m_\mu = -2.56 \times 10^{-5}$ and $\delta m_\tau / m_\tau = -7.32 \times 10^{-5}$.

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TABLE - *Quantum members and self-interaction masses for the leptons and quarks. Masses from (4) are in MeV except for the neutrinos, where eV magnitudes are indicated.*

	ξ	B	Q	P	n	m
ν_1	0	0	0	0	8	1.52×10^{-5} eV
e	0	0	–1	1	8	0.510999
u	0	⅓	⅔	1	8	2.044
d	0	⅓	–⅓	0	8	4.599
ν_2	–1	0	0	0	2	3.14×10^{-3} eV
μ	–1	0	–1	1	12	105.6557
c	–1	⅓	⅔	1	12	1173.95
s	–1	⅓	–⅓	0	2	105.6557
ν_3	1	0	0	0	4	5.28×10^{-2} eV
τ	1	0	–1	1	32	1776.07
t	1	⅓	⅔	1	32	177,607
b	1	⅓	–⅓	0	4	4933.53