The 3 neutrino masses & "Koide's formula"

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Abstract. Although all three neutrino masses currently are unknown, we deduce them all under the assumption of (the empirically established) "Koide formula."

Masses, since nonnegative, may be written as squares. Let X^2, Y^2, Z^2 denote the rest masses of the three *leptons*: electron, muon, tauon. The "Koide formula," an empirical discovery by Yoshio Koide in 1981 having no known theoretical explanation, states that

$$[X^2+Y^2+Z^2]\,[X+Y+Z]^{-2} = 2/3$$

or equivalently that the angle between the 3-vectors (1,1,1) and (X^2, Y^2, Z^2) equals 45° exactly; or equivalently that

$$[X+Z+Y]^2\,[XY+YZ+ZX]^{-1} = 6.$$

If we substitute in the latest (year 2018 particle data group) estimates, in units of MeV/c^2, namely X^2=0.51099895000(15), Y^2=105.6583755(23), Z^2=1776.86(12), then we find 0.6666605(68) for 2/3, 44.99974(28) for 45, and 5.99989(12) for 6.

Koide's formula might (a) be an exact equality that is a consequence of some brilliant deeper theory of particle physics that humanity until now has been too stupid to find. Or (b): Koide's "equalities" might merely be approximate, due entirely to luck, and having no deep underpinnings whatever.

Since there are not too many simple dimensionless symmetric algebraic combinations of x,y,z, and also not too many simple fractions like 2/3 that seem a priori worthy of consideration, the fact that any pair of them works this well, would be fairly surprising in the absence of any underlying reason.

My purpose here is merely to point out that if we assume (a), and *assume* Koide's formula also holds for the three *neutrinos* (given that the neutrinos appear to be the uncharged versions of the electron, muon, and tauon) then that actually is enough to *deduce* (uniquely, and accurate to within a few percent) their three masses (x^2,y^2,z^2), which currently are unknown, from the experimental facts (Esteban et al 2020) that

$$|y^4-x^4|=(7.42\pm0.21)\times10^{-5}\ \mathrm{eV}^2/c^4, \quad |z^4-y^4|=(2.517\pm0.028)\times10^{-3}\ \mathrm{eV}^2/c^4$$

and the ordering assumption $x^2<y^2<z^2$:

$$x^2=0.01877(33)^2=0.000352(13),\ y^2=0.09285(65)^2=0.00862(12),\ z^2=0.22562(61)^2=0.05090(28).$$

If we assume all that *except* instead believe in the opposite ordering $x^2>y^2>z^2$, then we instead find:

$x^2=0.22581(76)^2=0.05099(34)$, $y^2=0.22418(62)^2=0.05025(27)$, $z^2=0.05459(15)^2=0.002980(16)$.

All these alleged neutrino masses are in units of eV/c^2.

Palanque-Delabrouille et al 2015 and Planck collaboration 2020 both claim that $x^2+y^2+z^2<0.12$ eV/c^2 based on evidence from cosmology. This bound is compatible with either of our Koide-deduced mass 3-tuples.

References

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