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April 23, 2007

Professors W. Fetscher and H.-J Gerber,
Institute for Particle Physics,
ETH Zürich,
CH-8093 Zürich,
Switzerland

Dear Profs. Fetscher and Gerber,

I recently read your report on the muon decay parameters in the Review of Particle Physics, p.440 (2006), and I was surprised by the fact that you attribute the parity non-conserving parameters ξ and δ to the paper by Bouchiat and Michel, Phys. Rev. 106, 170 (1957).

Louis Michel was, of course, a very important physicist and he certainly introduced the ρ parameter in muon decay. Claude Bouchiat is also a very distinguished physicist. However, as far as I can tell by examining the literature, the ξ and δ parameters were not introduced in their 1957 paper (your ref[4]), but rather in the paper "Muon Decay with Parity Nonconserving Interactions and Radiative Corrections in the Two-Component Theory", T. Kinoshita and A. Sirlin, Phys. Rev.107, 593 (1957) (see Eq.(2.4)), and in the paper by the same authors "Polarization of Electrons in Muon Decay with General Parity-Nonconserving Interactions", Phys. Rev. 108, 844 (1957) (see Eq.(1.1)). I may add that this was also part of the subject of my PH.D. Cornell Thesis "μ Meson Decay with Parity Nonconserving Interactions".

For a completely polarized muon at rest, and neglecting the electron mass in comparison with its energy, the distribution function derived by Kinoshita and Sirlin is

$$dN(x,\theta) = A\Big(3(1-x) + 2\rho(4x/3-1) - \xi cos\theta[1-x+2\delta(4x/3-1)]\Big)x^2 dx d\Omega \qquad \text{(I)},$$

which is Eq.(2.4) of the first paper. For a μ^+ the sign of the $cos\theta$ term is flipped. The definitions of ξ and δ in terms of the ten basic scalar, vector, axial vector, tensor and pseudoscalar couplings in the Hamiltonian are given in detail in the two papers. The variable x is the electron energy energy E divided by its maximum value. The terms proportional to m_e/E and higher were incorporated in later publications. Also, except for the term of $O(m_e/E)$, (I) is the same distribution as Eq.(2) of your review.

C. Bouchiat and L. Michel wrote a letter on the same subject, except for the radiative corrections (your reference 4), but the distribution function they derived is formally very different from (I). For example, when the terms of $O(m_e/E)$ are neglected, they obtained (see their Eq(2)) an expression proportional to

$[3(1-x)+2\rho(4x/3-1)][1-S\zeta cos\theta]$, where

$S=3[2\beta+(3\alpha-4\beta)(1-x)]/[2\rho+(9-8\rho)(1-x)]$ (II)

Furthermore, the dependence on the basic parameters is given in an footnote in a very complicated manner. Although (II) is probably equivalent to (I), it is obviously a very different parametrization. Note, in particular, that Eq(II) does not even contain a parameter δ or a parameter ξ. It seems to me that to state that Eq(II) is characterized by the parameters δ and ξ, aside from the Michel parameter ρ, requires a large stretch of imagination.

At the time of writing the above papers with Kinoshita, I was a graduate student at Cornell and I remember that we searched for a nice parametrization that would be useful to experimental and theoretical physicists and, moreover, easy to remember. In particular, we chose the δ parameter term in the $cos\theta$ cofactor so that it is very similar to the ρ term in the parity conserving part,and also vanishes when one integrates over all electron energies. Moreover, both equal 3/4 in the two-component theory as well as in the Standard Model.

Aside from the two papers mentioned above, I wrote with Kinoshita three additional letters and one paper concerning muon decay:
"Polarization of Electrons in Muon Decay and Two Component Theory of the Neutrino", Phys. Rev. 106, 1110 (1957).
"Radiative Corrections to Asymmetry Parameter of Low-Energy Positrons in Muon Decay", Phys. Rev. 107, 638 (1957).
"Radiative Muon Decay". Phys. Rev. Lett. 2, 177 (1959).
"Radiative Corrections to Fermi Interactions", Phys. Rev. 113, 1652 (1959).

Years later, I co-authored a review paper and wrote a second one:
"Muon Decay" (with A.M. Sachs), contribution to the book "Muon Physics", Vol.II, edited by V.H. Hughes and C.S. Wu (Academic Press (1975).
"Muon Decay"", Proceedings of the Workshop on "Muon Physics", Aug. 8-10, 1980, TRIUMF, University of British Columbia, Vancouver, Canada.

I hope that this bibliographical information is useful and that, in future reviews, you may find possible to include, among your references, the first two papers mentioned above, that really introduced the ξ and δ parameters. In your review, the second paper is referred to in a different context, and the original first one is not mentioned at all. It seems to me that it would be fair and scientifically correct to refer to these two papers in connection with the introduction and definition of the ξ and δ parameters, and the derivation of the distribution function currently employed. You could still refer also to the paper by Bouchiat and Michel by stating, for instance, that a different parametrization of the parity nonconserving part of the distribution function was independently derived in Ref.[4]. In this way, a reader that consults the original literature will be able to understand how and where these parameters

and distribution functions were introduced, and why the parameters ξ and δ don't appear in the distribution function of Ref.[4].

With best regards,

Sincerely,

Alberto Sirlin
Professor of Physics

cc: Prof. T. Kinoshita, Cornell Univ.; Prof. W.J. Marciano, Brookhaven National Laboratory; Prof. G. Marshall, TRIUMF.