Erratum: Polarized neutron β-decay: Proton asymmetry and recoil-order currents [Phys. Rev. C 72, 045501 (2005)]

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While the matrix element and solution to the integral are correct as described, bookkeeping errors render the principal result of the paper incorrect. To be more precise, Equation (11) should be replaced by

$$d^2\Gamma = \frac{2|G_F|^2|g_V|^2}{(2\pi)^3}(m_n R)^4 \beta x^2(1-x)^2[1+\ 3\lambda^2 + C_0'(R,x) + C_p\cos\theta_p]dE_e d\cos\theta_p. \quad (1)$$

The C_0' term consists of isotropic recoil-order terms in this observable and is given by

$$\begin{aligned} C_0' = {} & 2R[x-\lambda(1-x-\beta^2 x)-\lambda^2(1-4x-\beta^2 x)] - 4Rf_2\lambda(1-x-\beta^2 x) \\ & -2Rg_2\lambda(2+x-\beta^2 x) + 2Rf_3 x(1-\beta^2). \end{aligned} \quad (2)$$

The proton asymmetry can be found by writing

$$\begin{aligned} d^2\Gamma &= f(x)(1+A_p\cos\theta_p)dE_e d\cos\theta_p, \\ A_p &= \frac{C_p}{1+3\lambda^2+C_0'}. \end{aligned} \quad (3)$$

Here are the correct expressions for Equations (12) and (13):
For $E_e < E_c$:

$$\begin{aligned} A_p = {} & -\frac{2\lambda}{3(1-x)^2(1+3\lambda^2)}(3(1+\lambda)(1-x)^2 + \beta^2 x[2-3x-\lambda(2-x)]) + \frac{2R\lambda}{15(1-x)^2(1+3\lambda^2)^2}(15(1-x)^3(1+\lambda)(\lambda-1)^2 \\ & -5\beta^2 x[1-3x+4x^2+\lambda(3-5x+4x^2)-\lambda^2(9-11x-4x^2)+\lambda^3(5-3x+4x^2)] + \beta^4 x^2(\lambda+1)[3x+10\lambda(2-3x) \\ & -\lambda^2(20-19x)]) + \frac{4Rf_2\lambda}{15(1-x)^2(1+3\lambda^2)^2}(15(1-x)^3(\lambda-1)^2 + 5\beta^2 x(1-x)[4x-3+2\lambda+\lambda^2(1+4x)] \\ & +\beta^4 x^2[3x+\lambda(20-30x)-\lambda^2(20-19x)]) - \frac{2Rg_2}{15(1-x)^2(1+3\lambda^2)^2}(15(1-x)^2(\lambda-1)[x+\lambda(2+x)-2\lambda^2(1-x)] \\ & -5\beta^2 x[1-2x-2\lambda(2-x)+\lambda^2(1-10x+12x^2)+2\lambda^3(1-3x+2x^2)] - \beta^4 x^2[x+\lambda^2(20-27x)-10\lambda^3(2-x)]) \\ & -\frac{2Rf_3\lambda(\lambda-1)x}{3(1-x)^2(1+3\lambda^2)^2}(3(1-x)^2(1+3\lambda) - \beta^2[3-10x+8x^2+3\lambda(3-6x+4x^2)] \\ & -\beta^4 x(4-5x-3\lambda x)) + \mathcal{O}(R^2). \end{aligned} \quad (4)$$

For $E_e > E_c$:

$$\begin{aligned} A_p = {} & \frac{2\lambda}{3\beta x^2(1+3\lambda^2)}((1-x)(1-3x)-\lambda(1-x^2)+3\beta^2 x^2(\lambda-1)) + \frac{2R\lambda}{15\beta x^2(1+3\lambda^2)^2}((1-x)[13-21x-2x^2 \\ & +\lambda(3-41x+28x^2)+\lambda^2(39-103x+34x^2)-\lambda^3(31+3x-4x^2)] - 5\beta^2 x(1+\lambda)[3x(1-2x)+2\lambda(1-x) \\ & -\lambda^2(2-3x+10x^2)] + 30\beta^4 x^3\lambda(1-\lambda^2)) + \frac{4Rf_2\lambda}{15\beta x^2(1+3\lambda^2)^2}((1-x)^2[3+2x+10\lambda(1-3x)-\lambda^2(1+4x)] \\ & -5\beta^2 x[3x(1-2x)+2\lambda(1-x)-\lambda^2(2-3x+10x^2)] - 30\beta^4 x^3\lambda(\lambda-1)) - \frac{4Rg_2}{15\beta x^2(1+3\lambda^2)^2}((1-x)[2-4x-3x^2 \\ & -5\lambda(1+x)-\lambda^2(4-13x-6x^2)-5\lambda^3(1-x^2)] - 5\beta^2 x[x-x^2-3\lambda x-\lambda^2(1-x+9x^2)+\lambda^3(1-3x+2x^2)] \\ & +15\beta^4 x^3\lambda^2(\lambda-1)) + \frac{4Rf_3\lambda(\lambda-1)}{3\beta x(1+3\lambda^2)^2}((1-\beta^2)[(1-2x)(1-x)-3x\lambda(1-x)-3\beta^2 x^2]) + \mathcal{O}(R^2). \end{aligned} \quad (5)$$

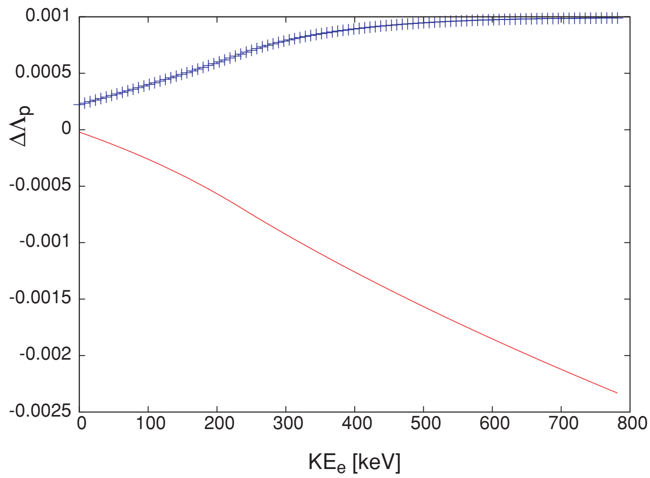

FIG. 3. (Color online) Possible changes in the proton asymmetry. The solid line is the change in Λ_p from f_2 set to 2.353 (as predicted by the CVC hypothesis) to $f_2 = 0$. The crossed line is the change in Λ_p from $\lambda = 1.2695$ to $\lambda = 1.2724$.

The discrepancies with the previous result only affect the recoil-order terms. The contributions of these errors to the proton asymmetry, β asymmetry, and the ratio of the two plotted in the original Figures 1, 2, and 5 are too small to be noticeable without magnification. The three figures included here replace the corresponding three figures in the original paper. The plots in the original paper mistakenly used $f_2/\lambda \approx 1.85$ for f_2; the following plots use the value properly prescribed by the CVC hypothesis of $f_2 = (\mu_p - \mu_n)/2 = 2.353$. Figure 3 shows a corrected version of the dependence of the proton asymmetry on f_2, the weak magnetism, and λ, which is the ratio of the axial-vector to vector coupling constants. Figure 4 shows a corrected version of the same dependencies of the β asymmetry on f_2 and λ. Note that at the maximum electron energy, the magnitudes of the recoil-order contributions in Figs. 3 and 4 are equal and opposite (the magnitude of the contributions of f_2 to the two asymmetries is the same); this is required by conservation of momentum in this limit. The f_2 contribution shifts the electron energy at which the proton's angular distribution is isotropic by 2.3 keV, not 1.9 keV. Figure 4 has only changed because of the different value of f_2 used. Figure 6 shows the dependencies of the ratio of the two asymmetries on the same parameters.

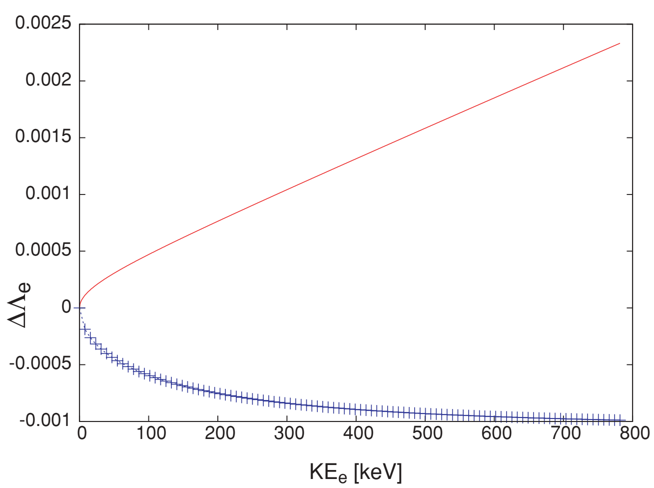

FIG. 4. (Color online) Possible changes in the β asymmetry. The solid line is the change in Λ_e from f_2 set to 2.353 (as predicted by the CVC hypothesis) to $f_2 = 0$. The crossed line is the change in Λ_e from $\lambda = 1.2695$ to $\lambda = 1.2724$.

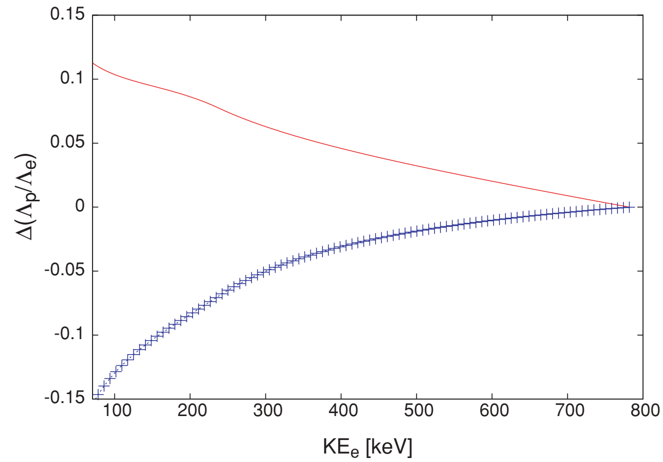

FIG. 6. (Color online) Changes in the ratio Λ_p/Λ_e. The solid line is the change in the ratio from $f_2 = 2.353$ to $f_2 = 0$. The crossed line is the change in the ratio from $\lambda = 1.2695$ to $\lambda = 1.2724$.

Despite the corrections, the overall trends in the recoil-order parameters do not change. Anything in the original paper not explicitly mentioned in this erratum is correct. The advantages of a simultaneous measurement of both the proton and β asymmetries, in terms of both systematic errors and sensitivity to f_2 and λ, remain.

I would like to thank D. Dubbers for bringing this problem to my attention.