On the pion electroproduction amplitude

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It has recently been claimed [1] that the pion electroproduction processes at threshold cannot be used to extract any information regarding the weak axial form factor. On the other side, the nucleon weak axial form factor and the induced pseudoscalar were extracted from the pion electroproduction in [2]. In our recent analysis [3] we have constructed the pion electroproduction amplitude starting from the chiral Lagrangians of the $N\pi\rho a_1$ system.

One of them is the minimal Lagrangian [4] constructed from the heavy meson gauge (Yang–Mills) fields, which contains no more than two derivatives in each term. In this case, the production amplitude was constructed directly. As a result, it consists in the soft pion limit of the well–known nucleon Born, pion pole and of the Kroll–Ruderman terms. The last term contains the nucleon axial form factor.

The second Lagrangian was constructed [5] within the concept of hidden local symmetries and it was used to construct the production amplitude according to equation

$$f_\pi\, M^{nj}_\lambda(q,k) \stackrel{q\to 0}{\longrightarrow} iq_\mu \left\langle p'\right| \int d^4y e^{-iqy}\, T\left(\hat{J}^n_{5\mu}(y)\, \hat{J}^j_\lambda(0)\right) \left|p\right\rangle - \varepsilon^{jnm} \left\langle p'\right| \hat{J}^m_{5\lambda}(0) \left|p\right\rangle\,, \qquad (1)$$

where $\hat{J}^m_{5\lambda}(0)$ is the nucleon axial current. Actually, this way of construction was chosen also in [1]. In principle, one can construct the production amplitude directly as in the first case. The advantage of using Eq. (1) is that one can see how boson exchanges in the t–channel contribute. As a result, one gets the pion production amplitude of the same structure as above, in agreement with the prediction of current algebras and PCAC. Let us note that the constructed amplitudes do not contain the induced pseudoscalar.

Our conclusions are

- The measurement of the induced pseudoscalar in [2] is not well founded.
- If the model used for construction of the pion electroproduction amplitude respects the local chiral symmetry, then in the soft pion limit, the form factor present in the Kroll–Ruderman term, is the nucleon axial form factor $F_A(k^2)$, in agreement with the current algebras and PCAC. If the dynamics of the model is governed by the gauge invariance only, then this form factor is $F^V_1(k^2)$.

References

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