Weak Form Factors from Pion Electroproduction at Threshold: A Phenomenological Approach.

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Summary. — We re-analyse data of threshold electroproduction assuming the transverse cross-section to be described exactly by a semi-phenomenological model previously adopted. The resulting experimental curve of the longitudinal cross-section is analysed to obtain information on the induced pseudoscalar form factor $G_P$.

1. — In this paper we want to analyse the data on $\pi^+$ electroproduction at threshold with the aim of obtaining information on the form factors appearing in the longitudinal part.

The interest of pion electroproduction in the threshold region has been extensively discussed in several works and review papers ($^1$). The main motivation of the attention, both experimental and theoretical, devoted to

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($^2$) E. AMALDI, S. FUBINI and G. FURLAN: *Electroproduction at low energy and hadron form factors*, ICTP, Trieste, Internal Report IC/77/36 (to be published in *Springer Tracts in Modern Physics*).
Weak form factors from pion electroproduction at threshold etc.

This process lies in the fact that, if one adopts the description based on soft-pion and PCAC low-energy theorems, its matrix element turns out to depend on the nucleon axial vertex $\langle N_2|A_\mu|N_1 \rangle$.

We recall a few facts about this quantity, whose standard expression is

$$\langle N(p_2)|A_\mu|^N(p_1) \rangle = \langle \tau^a/2 | \bar{u}(p_2) [\gamma_\mu G_A(t) + A_\mu G_p(t)] \gamma_5 u(p_1) =$$

$$= \langle \tau^a/2 | \bar{u}(p_2) \left( \gamma_\mu - 2M \frac{A_\mu}{t} \right) G_A(t) + \frac{A_\mu}{t} D(t) \right) \gamma_5 u(p_1), \quad t = \Lambda^2 = (p_2 - p_1)^2.$$

The purely longitudinal form factor

$$D(t) = 2MG_A(t) + tG_p(t)$$

is proportional to the matrix element of the divergence operator $\partial^\mu A_\mu$.

The direct source of information is, of course, represented by neutrino scattering ($\bar{\nu}p \rightarrow \mu^-n, \nu n \rightarrow \mu^-p$), which provides for $G_A(t)$ the dipole fit

$$G_A(t) = G_A(0)(1 - t/M_A^2)^{-2},$$

while the contribution of $G_p(t)$ to the cross-section turns out to be negligible. The most recent determination for $M_A$ from neutrino scattering on deuterium (3) is

$$M_A = (0.95 \pm 0.09) \text{ GeV}.$$

The only experimental information (4) available at present on $G_p(t)$ comes from $\mu$-capture on hydrogen, which occurs at $t_\mu \approx -0.88m_\mu^2$ and gives the range of possible values

$$6 m_\mu^{-1} < G_p(t) < 14 m_\mu^{-1}.$$

Coming back now to electroproduction, once the matrix element eq. (1) is known from the weak-interaction phenomenology, one has the possibility of describing that process in a manner alternative to the traditional one based on dispersion theory (which involves only electromagnetic hadron vertices). Conversely, the comparison of experimental data at threshold with soft-pion low-energy theorems may represent an alternative source of information on the axial form factors.

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