## N* PRODUCTION BY NEUTRINOS*)

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(presented by M.M. Block)

A phenomenological analysis of the N* production process,

$$\nu_\mu + n \to N^{*+} + \mu^- , \tag{1}$$

has been given by the present authors in a recent letter[1]. The most general production matrix element for this process involves eight form factors, $F_i^{V,A}(t)$ with $i = 1,2,3,4$, which are functions of the invariant momentum transfer squared, $t = -q^2$.

Recently Bég and Pais[2] have constructed an interaction in the SU(6) scheme to describe the general semi-leptonic process,

$$\nu_\ell + B(1) \to B(2) + \ell , \tag{2}$$

where B refers to a member of the $\underline{56}$ representation. Thus, the inelastic process (1) and the "elastic" process

$$\nu_\mu + n \to p + \mu^- \tag{3}$$

are related by the SU(6) symmetry properties. In this report we have calculated the N* production cross-section based on the SU(6) relationships and have compared these results with the CERN heavy liquid bubble chamber experiment[3].

For reaction (1), the predictions of SU(6) and the conserved vector-current (CVC) hypothesis lead to

$$\begin{aligned} F_1^A(0) &= -0.83 , \\ F_1^V(0) &= \phantom{-}3.5 , \\ F_2^V(0) &= -1.5 , \end{aligned} \tag{4}$$

where all the other five form factors, which are expected to be small, have been neglected[4]. By analogy with the elastic N-N form factors, for the above three N*-N transition form factors, we use the Hofstadter-type q dependence

$$F_i^{V,A}(-q^2) = \frac{F_i^{V,A}(0)}{(1 + q^2/b)^2} , \tag{5}$$

and choose $b = (0.855\ \mathrm{GeV})^2$ as fitted in the elastic case.

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*) This report reflects our preliminary results deduced from the SU(6) predictions of Bég and Pais

Our numerical results are summarized in Figs. 1 and 2 for the particular cases listed in Table 1. Case g refers to the prediction cited above of SU(6) and the CVC hypothesis for the neutrino reaction (1). We have also calculated the corresponding prediction for the antineutrino process,

$$\bar{\nu}_\mu + p \rightarrow N^{*o} + \mu^+ , \tag{6}$$

and it is listed as case f in Table 1. In addition, we have presented the numerical results for the extreme cases of pure axial vector (case a) and pure vector (case e) coupling. The experimental histogram for the neutrino production of $N^*$ is taken from Ref. 3 and has been scaled to the $n \rightarrow N^{*+}$ process, Eq. (1).

The SU(6) prediction for the magnitude of the direct axial-vector form factor is very compatible with the experimental information on the differential cross-section at low-momentum transfer which is determined principally by the axial-vector coupling constant, $GF_1^A(0)$. The predicted magnitudes and relative signs of these form factors in Eqs. (4), together with the adopted $q^2$ dependence in Eq. (5), are also seen to lead to a reasonable fit to the experimental total cross-section in Fig. 1.

On the other hand, one could also fit the total cross-section with $F_1^A$ alone by choosing an appreciably larger cut-off parameter b, in which case the neutrino and antineutrino cross-section would be identical. Thus, the observation of the antineutrino production of $N^*$ will determine the importance of the V-A interference effect and will serve as a sensitive test of the theoretical predictions.

Table 1

Form factors selected in the cases enumerated

| | $F_1^A(0)$ | $F_1^V(0)$ | $F_2^V(0)$ |
|---|---|---|---|
| Case a | -0.83 | 0 | 0 |
| Case e | 0 | 3.5 | -1.5 |
| Case f | 0.83 | 3.5 | -1.5 |
| Case g | -0.83 | 3.5 | -1.5 |

## REFERENCES

1) C.H. Albright and L.S. Liu, Phys.Rev. Letters 13, 673 (1964).

2) M.A.B. Bég and A.Pais, Phys.Rev. Letters 14, 51 (1965).

3) M.M. Block, H. Burmeister, D.C. Cundy, B. Eiben, C. Franzinetti, J. Keren, R. Møllerud, G. Myatt, M. Nikolic, A. Orkin-Lecourtois, M. Paty, D.H. Perkins, C.A. Ramm, K. Schultze, H. Sletten, K. Soop, R. Stump, W. Venus and H. Yoshiki, Physics Letters 12, 281 (1964).

4) Since this preliminary report was presented, we have been able to give more convincing arguments concerning the effects of the five form factors not specified by SU(6) and the CVC hypothesis, Phys.Rev. Letters (to be published).

## FIGURE CAPTIONS

Figure 1 : Total cross-section for the inelastic process $\nu_\mu + n \to N^{*++} + \mu^-$. The experimental results of Ref. 3 for $N^*$ production per nucleon have been scaled to the above-charge channel by dividing by two.

Figure 2 : Invariant differential cross for the inelastic process $\nu_\mu + n \to N^{*++} + \mu^-$ at $E_\nu = 2$ GeV.

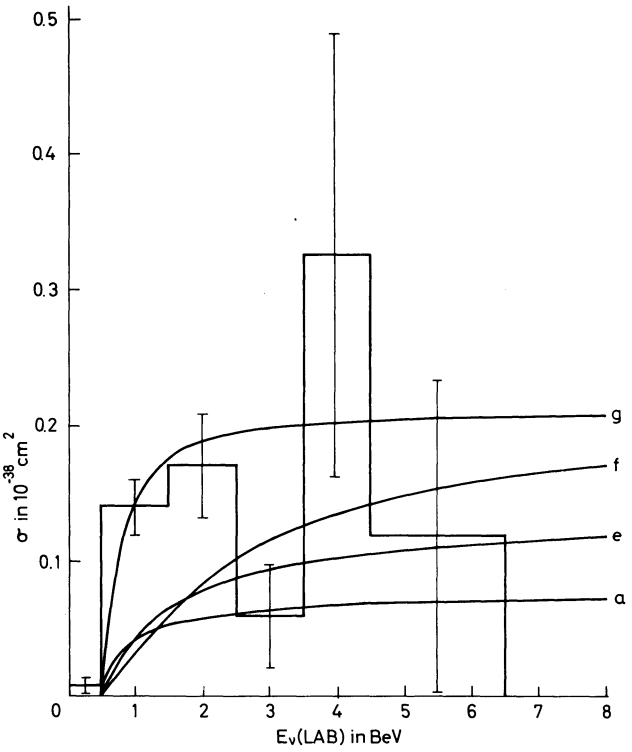
0.5
0.4
0.3
0.2
0.1
σ in $10^{-38}$ cm$^2$
g
f
e
a
0
1
2
3
4
5
6
7
8
$E_\nu$(LAB) in BeV

Fig. 1

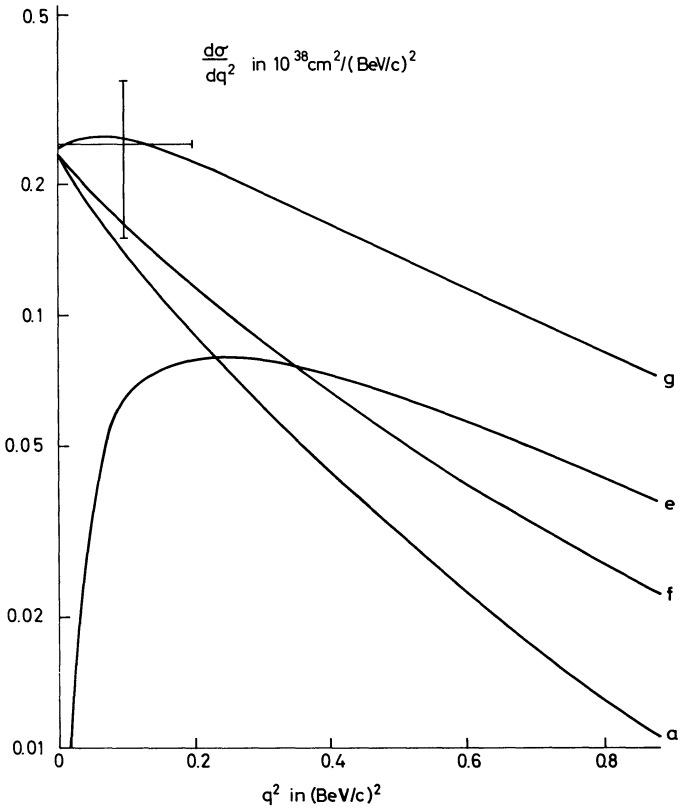
$\frac{d\sigma}{dq^2}$ in $10^{38}$cm$^2$/(BeV/c)$^2$
0.5
0.2
0.1
0.05
0.02
0.01
g
e
f
a
0
0.2
0.4
0.6
0.8
$q^2$ in (BeV/c)$^2$

Fig. 2