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COMPARISON OF SINGLE π^0 PRODUCTION BY ν AND $\bar{\nu}$ NEUTRAL CURRENTS

ν - $\bar{\nu}$ Propane Gargamelle Collaboration

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In the framework of $SU(2) \otimes U(1)$ gauge models, a parity conserving neutral current would yield equal π^0 production in muonless neutrino and antineutrino events. In this letter a combined analysis of single π^0 production in ν and $\bar{\nu}$ interactions is presented. The two experiments were performed with the bubble chamber Gargamelle filled with a light propane-freon mixture and exposed to the CERN PS ν and $\bar{\nu}$ beams. Identical experimental conditions [1,2] and similar selection criteria of the events ensure a considerable reduction of systematic error.

In both experiments, events are selected as follows:

- a) one or two materialized γ 's pointing to the vertex for the channel $\nu(\bar{\nu})p\pi^0$; two materialized γ 's pointing to the same origin for the channel $\nu(\bar{\nu})n\pi^0$;
- b) no μ nor charged pion candidates at the vertex;
- c) any number of protons. The definition of a proton in $\bar{\nu}$ events is a positive particle not recognised as a π^+ , stopping or interacting in the chamber, whilst in ν events it can also be a particle leaving the chamber.

The samples of ν and $\bar{\nu}$ induced π^0 events consist of 178 and 139 events respectively. They are separately corrected for losses and backgrounds of various kinds, which are summarized in Table 1. Further details are given in references [1] and [2].

Once normalized to the number of ν 's ($\bar{\nu}$'s) entering the chamber, these figures can be directly compared if the cross sections for π^0 production are independent of $E_{\nu, \bar{\nu}}$ or, in the case of energy dependent cross sections, if the shapes of the spectra are the same. Therefore, the comparison is restricted to the energy region $1 \text{ GeV} < E_{\nu, \bar{\nu}} < 4 \text{ GeV}$, where - to a good approximation - the shapes of the spectra are approximately the same (see fig.1). It should be noted that the cut at 4 GeV is not critical, excluding only a few percent of the events. The low energy cut is introduced because the ν and $\bar{\nu}$ fluxes are badly known below 1 GeV.

Taking into account the number of protons on target in the ν and $\bar{\nu}$ exposures, the fiducial volumes used, and integrating over the spectra between 1 and 4 GeV, the ratio between the number of incoming $\bar{\nu}$'s and ν 's turns out to be

$$\frac{\int_1^{4 \text{ GeV}} \phi(E_{\bar{\nu}}) dE_{\bar{\nu}}}{\int_1^{4 \text{ GeV}} \phi(E_{\nu}) dE_{\nu}} = 2.19$$

In this ratio the systematic errors in the determination of the intensity and shape of the ν , $\bar{\nu}$ spectra are less than about 2% and as a consequence will be neglected. The fraction of ν and $\bar{\nu}$ events rejected by the energy cuts was evaluated on the restricted sample of $\nu(\bar{\nu}) p\pi^0$ events with both γ 's converted and a single proton. The energy distributions of these events, as calculated from the momenta of the hadronic system, are however distorted by nuclear effects and backgrounds. These distortions were estimated by analyzing in a similar way a sample of $\mu^- p\pi^0$ and $\mu^+ p\pi^-$ events, for which the true incident energy is known from the total visible energy.

The final numbers (see Table 1) are then obtained by scaling up the restricted to the total sample, assuming that their energy distributions are the same.

The corrected number of $\bar{\nu}$ events thus obtained is:

$$\overline{NC}_{\pi^0} = 142 \pm 24$$

and the normalized number of ν events is:

$$NC_{\pi^0} = 309 \pm 55$$

In conclusion:

$$NC_{\pi^0} - \overline{NC}_{\pi^0} = 167 \pm 60$$

is a measurement of vector axial-vector interference and deviates from zero by about three standard deviations. The systematic error is included. This confirms the result, obtained with spark chambers by the Aachen Padova Collaboration ^[3] with similar statistics.

REFERENCES

- [1] W. Krenz et al., Nuclear Physics B135, 45 (1978).
- [2] O. Erriquez et al., Physics Letters 73B, 350 (1978).
- [3] H. Faissner et al., Physics Letters 68B, 377 (1977).
- [4] J.J. Sakurai - Proceedings of the International Neutrino Conference, Aachen 1976, page 515.

FIGURE CAPTION

Fig. 1 - ν and $\bar{\nu}$ energy spectra. They are normalized to the same number of ν 's and $\bar{\nu}$'s in the region 1 - 4 GeV.

TABLE I

Numbers of selected events corrected for backgrounds and losses in the two Gargamelle propane PS experiments		$\bar{\nu}$	$\bar{\nu}$
<p>p $\gamma(\gamma)$ + $\gamma\gamma$ observed events scan efficiency, random associations neutron background two pion events ($2\pi^0$ or 2π with 1 π absorbed) $\pi^{\pm}$'s taken as protons</p>		178	139
		+10.6	+3
		-28 $\pm$ 9.9	-12 $\pm$ 5
		-17 $\pm$ 4	-21 $\pm$ 4.6
		-5 $\pm$ 1.5	-6 $\pm$ 6
Events corrected for backgrounds		138 $\pm$ 17	103 $\pm$ 15
Events with 1 GeV < E_{γ} < 4 GeV		108 $\pm$ 19	92 $\pm$ 15
Events corrected for: detection efficiency for protons γ detection efficiency		141 $\pm$ 25	95 $\pm$ 16 142 $\pm$ 24