NEW RESULTS ON $\gamma \rightarrow \pi\pi\pi$ FROM JEFFERSON LAB

RORY MISKIMEN AND BURIN ASAVAPIBHOP
University of Massachusetts, Amherst MA, 01003 USA,
E-mail: miskimen@physics.umass.edu

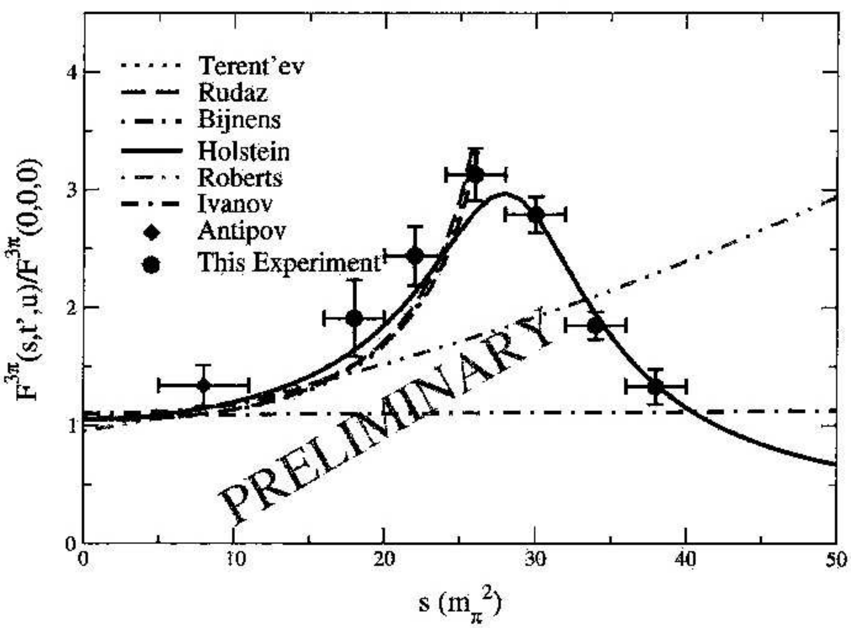
The chiral anomaly is arguably the most well understood and constrained process in low energy QCD. Because the anomaly is a short-range interaction, it doesn't have the hadronization problem that plagues the description of all low energy processes. The Wess-Zumino-Witten Lagrangian that describes the anomaly has no parameters other than fundamental constants, such as the number of colors N_C and the pion decay constant F_π, and it's prediction for the π^0 decay rate is in excellent agreement with $N_C = 3$. On the experimental side, many aspects of the anomaly are not well tested. In particular, the situation for the $\gamma \rightarrow 3\pi$ amplitude $F^{3\pi}$ is disturbing since it was measured at Serpukhov[1] by means of the Primakoff effect and was found to be consistent with $N_C = 4$. If this result is correct then it would signal a serious defect in our understanding of QCD.

At low t the two-pion photo-production reaction $\gamma p \rightarrow \pi^+\pi^0 n$ is related to the $\gamma \rightarrow 3\pi$ vertex by means of the t-channel pion exchange amplitude. In Jefferson Lab experiment E94-015 we use the sensitivity of the $\gamma p \rightarrow \pi^+\pi^0 n$ reaction to the $\gamma \rightarrow 3\pi$ vertex to measure $F^{3\pi}$. Cross sections were measured using the CLAS detector. The electron beam energy was 2.5 GeV for the data reported here, with photons from 20% to 95% of the electron energy incident on an 18 cm-long LH_2 target. The trigger for the experiment required hits in the tagger, the start counter (which surrounds the target), and the TOF scintillators. Differential cross sections were obtained as a function of s, t, $M_{\pi+n}$, and $\cos\theta_{\pi\pi}$, where $M_{\pi+n}$ is the π^+n invariant mass, and $\theta_{\pi\pi}$ is the π^+ emission angle in the $\pi\pi$ CM frame. Acceptance corrections to the data were calculated using the CLAS GEANT simulation program GSIM. $d^2\sigma/dsdt$ was calculated by summing over $M_{\pi+n}$ and $|\cos\theta_{\pi\pi}|<0.6$.

$F^{3\pi}$ was fit to the data using the Chew-Low method. Model-independent parameterizations were used, $d^2\sigma/dsdt\ (t-m_\pi^2)^2 = -A_0 t\ F_{N\pi N}^2(t) + A_1(t-m_\pi^2) + A_2(t-m_\pi^2)^2 + \ldots$, where $F_{N\pi N}(t)$ is the $N\pi N$ vertex form factor, taken here as the nucleon axial form factor, normalized to unity at the pole. Fits to the data were performed as a function of polynomial order and as a function of the low and high t cutoffs in the fit, with the requirement that A_0 should be stable with respect to these variations. Finally, corrections were made to the pole cross section for the restricted solid angle coverage of the cross sections, $|\cos\theta_{\pi\pi}|<0.6$ and $|\phi_{Lab}|<25^0$ within a CLAS sector, assuming a $\sin^2\theta_{\pi\pi}$ angular distribution in the CM frame.

The figure below shows preliminary results for $F^{3\pi}(s)/F^{3\pi}(0)$ over the s range from 18 to 38 m_π^2. The error bars shown in the figure are estimates of the systematic error from the Chew-Low analysis. The data point from Serpukhov[1] is also shown. Several theoretical calculations[2] are presented in the figure. Only the calculation of Holstein includes a finite width for the ρ^+, the other calculations take the ρ^+ as a zero width pole. The data are in agreement with all of the calculations up to s=26 m_π^2, which is at the upper limit of the range of validity for all the calculations except Holstein's. The data are in good agreement with Holstein's calculation over the entire experimental range in *s*.

Analysis of the data at $s<18$ m_π^2 is continuing. New CLAS data taken at 3 GeV will increase the size of the data sample by approximately a factor of 20. Cutting the data on the $n\pi$ invariant mass is also under study as a way to limit the effect of $\Delta\pi$ final states on the Chew-Low analysis.



1. Yu. M. Antipov, *et al.*, Phys. Rev. D36, 21 (1987).
2. B.R. Holstein, Phys. Rev. D53, 4099 (1996), and references therein.