CEBAF EXPERIMENT 93-033

A Search for Missing Baryons Formed in $\gamma p \rightarrow p\pi^+\pi^-$ Using the CLAS at CEBAF

J. Napolitano (Spokesperson), G.S. Adams,
M. Witkowski, P. Stoler, and J. Price

Rensselaer Polytechnic Institute

D.M. Manley

Kent State University

with the CLAS Real Photon Working Group

and the CLAS Collaboration

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J. Napolitano, Spokesperson

The quark model gives an excellent description of the static properties of hadrons. This is quite surprising, since it is not at all clear how Quantum Chromodynamics (QCD), the accepted theory of the strong interactions, reduces to the quark model in the static limit. Any serious discrepancy between the quark model and experiment may teach us something important about QCD and how it may eventually be solved in the non-perturbative regime.

In fact, a serious disagreement between the quark model and the baryon spectrum has existed for quite some time. A large number of positive parity non-strange baryons, which would lie in the $N = 2$ harmonic oscillator band, appear to be missing.[1] An intriguing solution to this problem was originally put forth by Lichtenberg[2] who suggested that pairs of quarks bind tightly into "diquarks" with a particular set of quantum numbers. Baryons, then, are *quark-diquark* systems, and the reduced symmetry nicely accounts for the missing states.

However, a less drastic solution has been suggested. Nearly all the data on the non-strange baryon spectrum consists of experiments with $N\pi$ in the initial or final state, or both. If the missing baryons do not couple to $N\pi$, they would not have been discovered, and dynamical quark model calculations strongly support this hypothesis.[3] On the other hand, these states do not have anomalously small couplings to photons[4], or to $N\pi\pi$ final states such as $\Delta\pi$ or $N\rho$.[5]

Our experiment will measure the reaction $\gamma p \rightarrow p\pi^+\pi^-$, which therefore includes various final states including $\Delta^{++}\pi^-$, $\Delta^0\pi^+$, $N\rho^0$, as well as those with the $\pi^+\pi^-$ in a relative S-state or with excited baryons such $N\frac{1}{2}^+(1440)$ and $\Delta\frac{3}{2}^+(1600)$. The data will be taken with the CLAS photon tagger and a 2.4 GeV incident electron beam, allowing us to probe baryon masses between the $\Delta\pi$ threshold and 2.3 GeV/c^2. The CLAS will be triggered on a single charged particle in coincidence with the tagged photon, but offline selection will require at least two charged particles in the CLAS. The requirement of ≥ 2 charged particles (identifying the third with missing mass) assures full acceptance with no large acceptance corrections, while the simple trigger allows concurrent running with other experiments. Including prescaling requirements to promote compatibility, this experiment will acquire more than 10^8 events of the reaction $\gamma p \rightarrow p\pi^+\pi^-$, increasing the existing data set by several orders of magnitude.

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[1] F.E. Close, "An Introduction to Quarks and Partons", Academic Press (1979)
[2] D.B. Lichtenberg, Phys.Rev. **178**(1969)2197
[3] S. Capstick and W. Roberts, Phys.Rev.D. **47**(1993)1994
[4] S. Capstick, Phys.Rev.D. **46**(1992)2864
[5] S. Capstick and W. Roberts, Phys.Rev.D. **49**(1994)4570