The study of the electromagnetic N* transition form factors with CLAS12 at Jefferson Lab

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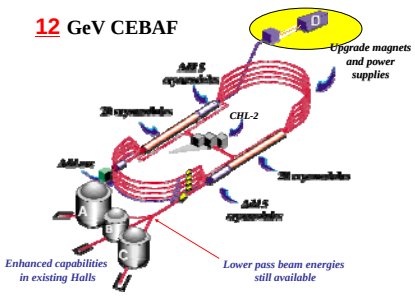
Abstract

We will discuss the program to study the electromagnetic N* transition form factors with the CLAS12 detector and the energy upgraded 12 GeV CEBAF beam at Jefferson Lab. The goal of this program is to explore the evolution of the active degrees of freedom in excited nucleon states from meson-baryon dressing to dressed quark contributions, and to learn how the strong interaction creates dressed quark cores in various N* and how they emerge from QCD.

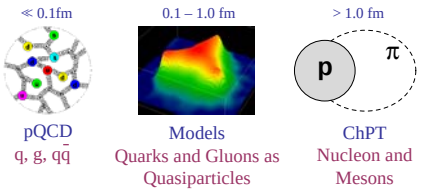
We plan to measure exclusive single-meson and double-pion electroproduction cross sections off a proton target to study the nucleon resonances. Exclusive final states will be measured including the identification of π^0 and η mesons by measuring the two decay photons as well as of charged multi-pions (π^+,π^-). From the proposed measurements, we expect to obtain the electromagnetic transition form factors for well established excited nucleon states in the unexplored domain of Q^2 from 5.0 to12.0 GeV^2.

The close collaboration experimentalists and theorist will allow us to provide high-precision data, high-quality analyses, as well as state of the art model and QCD based calculations.

Jefferson Lab



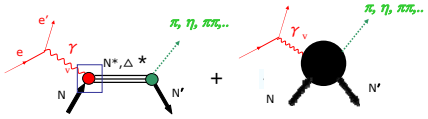
Physics Goals



- Determine the electrocouplings of prominent excited nucleon states (N*, Δ*) in the unexplored Q^2 range of 5-12 GeV^2 that will allow us to:
  - Study the structure of the nucleon spectrum in the domain where dressed quarks are the major active degrees of freedom.
  - Explore the formation of excited nucleon states in interactions of dressed quarks and their emergence from QCD.

How N* electrocouplings can be accessed

- Isolate the resonant part of production amplitudes by fitting the measured observables within the framework of reaction models, which are rigorously tested against data.
- N* electrocouplings can then be determined from resonant amplitudes under minimal model assumptions.



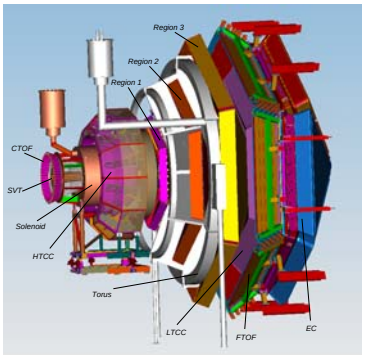
$A_{3/2}$, $A_{1/2}$, $S_{1/2}$
G_M, G_E, G_C

Non-resonant amplitudes.

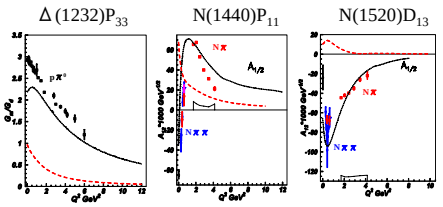
Consistent results on N* electrocouplings obtained in analyses of various meson channels (e.g. *πN, ηp, ππN*) with entirely different non-resonant amplitudes will show that they are determined reliably

CLAS12

CLAS12 Detector Base Equipment at Hall B at 12 GeV upgraded CEBAF



Progress in Experiment and Phenomenology



Dressed quarks (I. Aznauryan; M.Giannini, et al ; B.Julia-Diaz, et al.)

Meson-baryon cloud (EBAC)

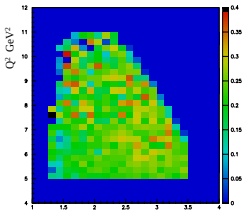
Recent experimental and phenomenological efforts show that meson-baryon contributions to resonance formation drop with Q^2 faster than contributions from dressed quarks.

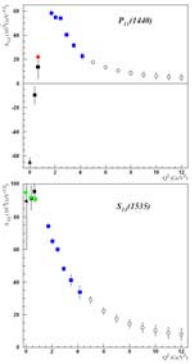
Expected Results

60 days run, L= 10^{35} cm^{-2} sec^{-1},
ΔW = 0.025 GeV,
ΔQ^2 = 0.5 GeV^2

Genova-EG

(e',pπ$^+$π$^-$) detected





Conclusions

Our new experiment will provide data for:

- 1π and 2π independent analyses in the unexplored 5<Q^2<12 GeV2 region.
- Combined 1p and 2p analysis.
- Full coupled channel analysis developing by Extended Baryon Analysis Center (EBAC) at Jefferson Lab.
- First results on N* electrocouplings at the distance scales corresponding to major contribution from dressed quarks needed for broad international collaboration between experimentalists and theorists in order to explore non-perturbative strong interactions of dressed quarks responsible for baryon formation and their emergence from QCD.
- Shed light on origin of major part of hadronic mass in Universe.

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