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Amplitudes for the $S_{11}(1535)$ and $P_{11}(1710)$ Resonances from an $ep \rightarrow e'p\eta$ experiment

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This experiment is part of the *N** program at CEBAF. A number of difficult experiments that share similar detection techniques are being pursued by a collaboration of about 20 university groups. The basic goal is to study the quark structure of the proton and its excited states. By understanding a group of states bound by the strong interaction, the fundamental characteristics of that force can be learned.

The difficulties in learning the fundamental nature of the strong interaction have been significant because of the components of the proton - quarks and gluons - don't seem to exist by themselves. In high energy electron+proton inelastic scattering experiments, the signature of quarks is reasonably clear in the scaling relationships discovered at SLAC. At intermediate energies, the strong force is more complicated, perhaps even more interesting because new combinations of quarks and gluons can occur due to a much stronger coupling strength. The main evidence for quarks at CEBAF energies is in the energy spectrum of proton excited states. The *N** program will greatly extend this knowledge by studying the electromagnetic coupling strength between the proton and the excited states. This strength will be a direct test of any theoretical wave function that purports to be correct for the states involved.

Any experiment attempting to study the *N** spectrum via inelastic electron-nucleon (proton or neutron) scattering has to cope with wide overlapping states and a significant strength for excitation by mechanisms that don't include a resonance. Many methods of analysis have been developed to do this, including looking at angular distributions and spin structure of a wide range of final states involving mesons of varying quantum numbers. One way to focus on a small subset of reaction possibilities is to look for an η in the final state. Based on previous data, this meson seldom interacts with nucleons in ways that don't involve resonances and seems to couple strongly to very few excited states. Thus, the analysis of that particular kind of data is greatly simplified.

This experiment will examine all events in electron+proton interactions with an η in the final state. The beam energies of CEBAF are ideal for this experiment. The CLAS spectrometer will be of great importance in allowing the detection of events with a wide range of kinematical parameters in the final state at a single setting. These data can be taken with CLAS in the configuration proposed in the Conceptual Design Report of 1990. The states expected to be strongly seen in this channel are $S_{11}(1535)$ and $P_{11}(1710)$. The former is a strongly excited state that has been very difficult to understand from quark models, in large part because its transition form factor is quite different from states in the same SU(6) group. The P_{11} is weakly excited and even more poorly understood because the existing data is of such poor quality. Its properties are very poorly described by existing quark models, leading some to suggest it is a state with large admixtures of gluons, i.e., a hybrid state. In the overall *N** program, the full spectrum of states will be studied by taking data for all possible final states. We expect to increase the quality of the world's data by more than an order of magnitude in two ways (1) a new determination of the energy spectrum for nucleon excited states and (2) a greatly improved set of electromagnetic coupling constants for these states.