Excited nucleons and their structure with CLAS

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Nucleons represent the simplest system where the non-abelian nature of QCD is manifest (N. Isgur). Their nucleon excitation spectrum reflects properties of the 3-quark and gluon system and their interaction. Microscopic approaches such constituent quark models as well as Lattice QCD, make predictions regarding masses and quantum numbers of the excited states and their internal structure according to radial, spin, and orbital transitions of the quark-gluon system. These transitions may be probed by transferring energy into the system and observing hadronic (or electromagnetic) decays of the excited states. Pion induced transitions have revealed many nucleon states consistent with quark model predictions, but many of the predicted states have not been observed, especially in the mass range above 1.8 GeV. The quest for a better understanding the internal structure of baryons has led to a worldwide effort to measure nucleon excitations using photon- and electron-induced processes. The CLAS detector at JLab plays a key role in measuring many of these processes. Differential cross sections and polarization observables have been measured with unprecedented precision and some of these data have been used in coupled-channel resonance analyses that led to evidence for a number of new excited states. Much more data in many different channels, and including double and even triple polarization observables, are being analyzed and will be available in the near future for coupled-channel resonance analysis efforts. The transition charge and magnetization densities can be accessed through meson electro-production experiments, where the resolving power of the virtual photon is used to reveal the internal structure. In this talk, I will discuss both efforts, the search for new nucleon states using meson photo-production and the study of resonance transition form factors and transition charge and magnetization densities and their role in understanding the internal structure and the nature of excited states. The example of the Roper resonance is used to demonstrate the sensitivity of transition form factors as a tool to discriminate between ordinary baryons and hybrid baryons.

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