working group #6: Baryon Spectroscopy

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Goal: Proposal for the measurement of polarization observables in η photoproduction off the nucleon with the Crystal Barrel/TAPS experiment at ELSA.

Photons are able to excite atoms as well as their nuclear constituents, protons and neutrons, even if the needed energies are more than 10 Mio. times larger for the later case. Obviously the proton and neutron are not elementary. Assuming that they are made out of three quarks with similar mass and using an appropriate potential, quark models describe the measured spectrum of such excited states or resonances, the baryon spectrum, quite well. At least there are no unmeasured but predicted states below center of mass energies of $W = 1800\,\mathrm{MeV}$. For higher energies the number of predicted states exceeds the number of measured states by far and one can doubt if these states really exists.

Unfortunately, the theory of the strong force between the quarks, Quantum Chromodynamics (QCD), is not solvable in the energy regime of light baryons. Here, the expansion in a perturbative series does not converge due to the large coupling constant and quarks are confined in hadrons. Lattice QCD provides a possibility to extend QCD into this non-perturbative regime, but to this day some approximations have to be made. Lattice calculations confirm the rich spectrum predicted by quark models. Therefore one of the main tasks of hadron spectroscopy is to find out what the effective degrees of freedom and forces between them are in the regime of non perturbative (strong) QCD.

Baryon resonances are broad and overlap with other baryon resonances wherefore polarization experiments are needed to disentangle unambiguously the contributing resonances to a final state. The much improved Crystal Barrel/TAPS experiment will again start data taking in 2015 with linear or circular polarized beam and/or longitudinal and transversal polarized proton or deuteron target allowing the measurement of all single polarization observables and all double polarization observables accessible with beam and target polarization.

In this working group you will learn something about scattering theory, quark models, partial wave analysis, polarization observables and complete experiments, detection of photons and charge particle identification.