Search for Baryonic Resonances Decaying to $\Xi\pi$ in Deep-Inelastic Scattering at HERA

In the standard model of particle physics all known strongly interacting particles can be described as bound states of a quark and an anti-quark (mesons) or of three quarks (baryons). By the end of the year 2003 a new resonance state was reported by the LEPS Collaboration that did not fit into this scheme. If existing, such a new state is assumed to be built of at least four quarks and an anti-quark. Such (hypothetical) states are commonly known as pentaquarks. In the following years several theoretical models were worked out trying to classify this new class of particles. Most of them predict a flavour anti-decouplet for the light pentaquarks (consisting of the light quarks u, d, and s only). Among these, the two states Ξ_{5q}^{--} and Ξ_{5q}^{0} are expected to decay according to:

$$\begin{aligned} X^{--} &\rightarrow \Xi^-\pi^- \rightarrow [\Lambda\pi^-]\pi^- \rightarrow [(p\pi^-)\pi^-]\pi^- \\ X^{0} &\rightarrow \Xi^-\pi^+ \rightarrow [\Lambda\pi^-]\pi^+ \rightarrow [(p\pi^-)\pi^-]\pi^+ \,. \end{aligned} \tag{1}$$

This paper describes a search for these two new particles in deep inelastic ep scattering (DIS) at HERA with the H1 experiment.

In this analysis the full decay chain given by equation 1 is reconstructed. This includes also reconstruction of tertiary vertices as the Ξ^- and Λ baryons travel several centimeters before they decay. Figure 1 shows in the upper part the spectra of the reconstructed invariant mass of the same ($\Xi^-\pi^-$) and opposite charged ($\Xi^-\pi^+$) combinations. In the latter a clear signal from the standard (excited) baryon $\Xi(1530)^0$ is observed. Apart from this no other significant structures are seen. Therefore there is no indication for the Ξ_{5q}^{--} or the Ξ_{5q}^{0} states. To quantify these non-observations, a mass-dependent upper limit at the 95 % confidence level (C.L.) on the production ratio of any new, narrow baryonic states decaying to $\Xi^-\pi^\pm$ with respect to the well established $\Xi(1530)^0$ are calculated. These upper limits are shown in the lower part of figure 1.

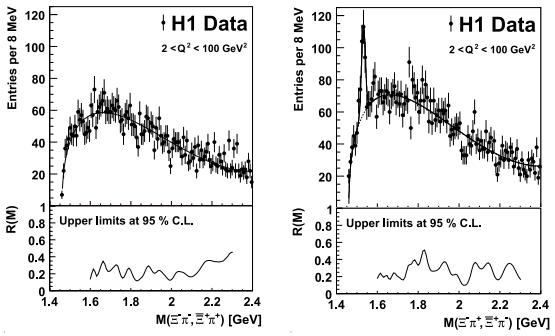

Figure 1: Mass spectra of the opposite charged ($\Xi^-\pi^-$, rigth) and same charged ($\Xi^-\pi^+$, left) combinations and upper limit.

In conclusion, no signal of a new baryonic state is found in the mass range $1600-2300\,\mathrm{MeV}$ and mass dependent upper limits at the 95% C.L. are set on the production ratio of hypothetical states, such as the Ξ_{5q}^{--} and Ξ_{5q}^{0} , to the total number of observed $\Xi(1530)^0$ baryons. The results reported here from H1 are similar to the limits measured by our partner experiment, the ZEUS Collaboration.