Annual report

Search for Θ^+ via $\pi^- p \to K^- X$ reaction at E522 experiment

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Since the report on the evidence of an exotic baryon Θ^+, many studies from both theoretical and experimental aspects have been conducted. The Θ^+ is predicted by Diakonov *et al.* using chiral soliton model and is considered to be manifestly exotic baryon which have unusual quark contents of $uudd\bar{s}$. The observation at SPring-8/LEPS was immediately confirmed by several experiments. Recently, however, null results have been reported from several high-energy experiments where investigators searched for Θ^+ using higher statistics. Therefore, in such a situation, the confirmation of Θ^+ is urgent and crucial.

In this situation, a Θ^+ search was conducted via the $\pi^- p \to K^- X$ reaction with the experimental resolution of 13.4 MeV FWHM using 1.87 and 1.92 GeV/c π^- beam at the K2 beam line of the KEK 12 GeV Proton Synchrotron (KEK-PS). A polyethylene (CH_2) target was exposed to 3.0×10^9 π^-'s of 1.87 GeV/c and 7.4×10^9 π^-'s of 1.92 GeV/c. Additionally, 2.9×10^9 π^-'s of 1.87 GeV/c were irradiated on a scintillating fiber (mostly CH) target. While no peak corresponding to Θ^+ was observed for 1.87 GeV/c, a hint of peak structure, of which width was consistent with the experimental resolution, was observed at the mass of $1530.6^{+2.2}_{-1.9}(\text{stat.})^{+1.9}_{-1.3}(\text{syst.})$ MeV/c^2 for 1.92 GeV/c. However the statistical significance of the bump is only 2.5∼2.7σ which is not sufficient to claim the existence of the Θ^+. We have derived the upper limit of the production cross section to be 1.8 μb and 3.9 μb at the 90 % confidence level for 1.87 and 1.92 GeV/c,respectively, assuming that the Θ^+ is produced isotropically in the center of mass system.

The obtained upper limits are quite smaller than the theoretical calculations and give a strong constraint to the unknown parameters such as the coupling constant $g_{K^*N\Theta}$ used in the calculations. Using the present results, the cross section of the $K^+ p \to \pi^+ \Theta^+$ reaction has been studied by T. Hyodo and A. Hosaka. They find that the ratio of the cross sections of π^- and K^+ induced reactions are quite different for two J^P assignments of the Θ^+. In the case of $J^P = 1/2^+$, $\sigma(K^+ p \to \pi^+ \Theta^+)/\sigma(\pi^- p \to K^- \Theta^+)$ is ∼50, while in the case of $J^P = 3/2^-$ it is ∼3.3. An experiment to search for the Θ^+ via $K^+ p \to \pi^+ X$ reaction has been performed at KEK. This experiment together with the present results will provide deeper understanding on the existence of the Θ^+.
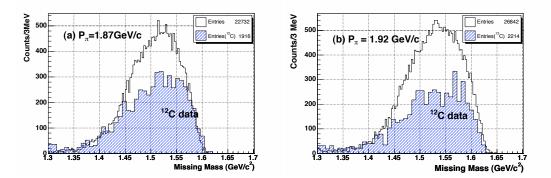
Present results are published in [1].

Figure 1: Missing mass spectrum obtained in E522. Left: $p_{\pi^-} = 1.87$ GeV/c. Right: $p_{\pi^-} = 1.92$ GeV/c. A bump structure is seen at 1.53 GeV for 1.92 GeV/c.

[1] K. Miwa *et al.*, Phys. Lett. B 635 (2006) 72.