MEASUREMENT OF ASYMMETRY PARAMETER IN RADIATIVE DECAY $\Sigma^+ \to p + \gamma$ (E761 experiment, FNAL)

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The main goal of the E761 experiment [1,2] was to measure the asymmetry in the radiative decay $\Sigma^+ \to p\gamma$. The previous world statistics (three experiments) contained only about 300 events [3]. These experiments indicated quite a big negative asymmetry in the decay in contradiction with the results of numerous theoretical calculations. The experimental study of the $\Sigma^+ \to p\gamma$ decay is complicated by the presence of a more intense (a factor of 400) background reaction $\Sigma^+ \to p\pi^0$, which is kinematically similar to the reaction under investigation. The reliability of the available experimental data was not obvious because of the small statistics and also because of possible admixture of the $\Sigma^+ \to p\pi^0$ events with the asymmetry of about -1.0.

The E761 experiment was aimed to carry out the measurements of the asymmetry in the radiative decay $\Sigma^+ \to p\gamma$ with much higher statistics as well as with much better separation from the background reaction. The hyperon channel of the Fermilab accelerator (Batavia, USA) provided a high intensity beam of polarized Σ^+-hyperons that made it possible to collect about 50000 events in the decay channel $\Sigma^+ \to p\gamma$. To separate the $\Sigma^+ \to p\gamma$ reaction from the background, the emitted gammas were detected in addition to high precision measurements of the momenta of the Σ^+-hyperons and the outgoing protons.

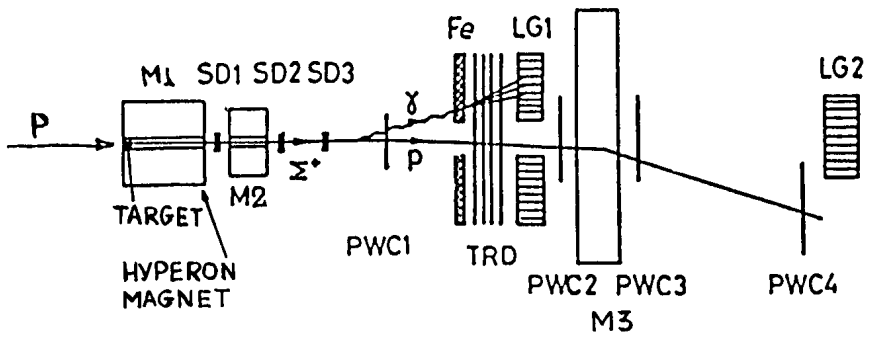

Fig.1. Layout of E761 experiment at Fermilab charged hyperon beam

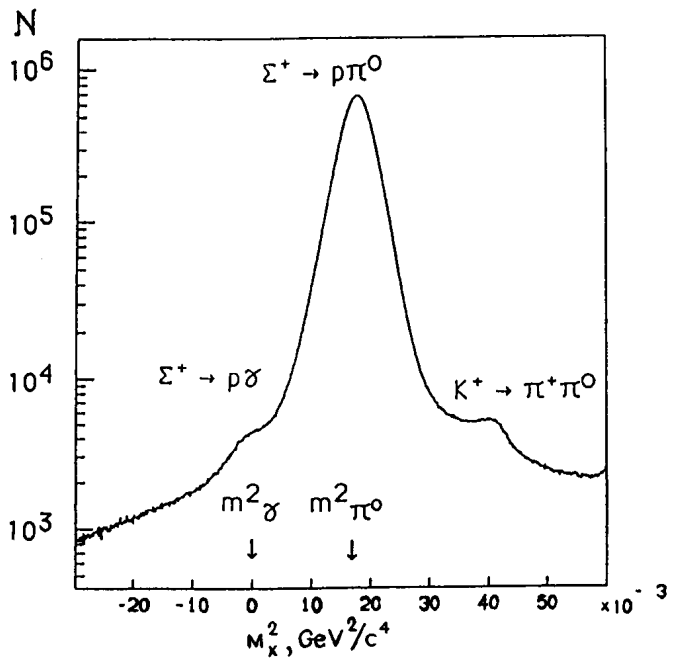

Fig.2a. Missing mass distribution for reaction $\Sigma^+ \to p + X$ determined without taking into account coordinate and energy of photon

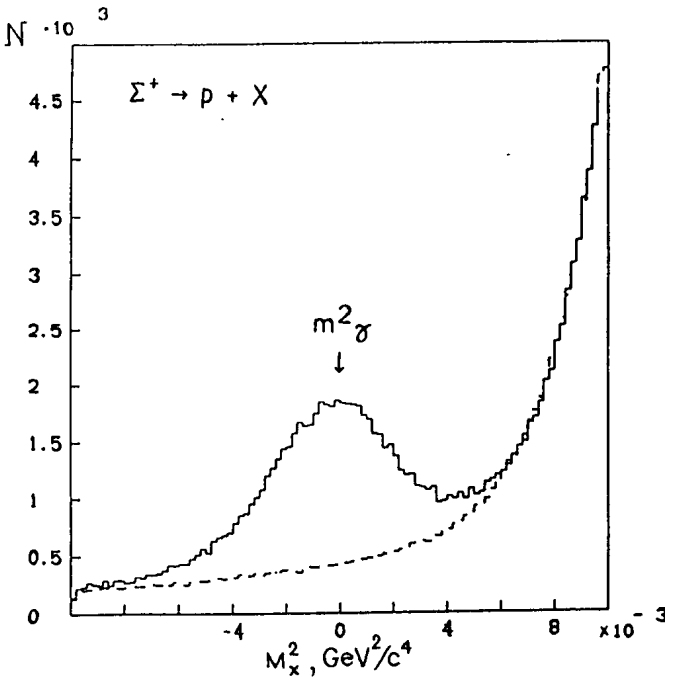

Fig.2b. Same distribution for events selected by using information from photon detector

Fig.1 shows the layout of the experiment. The charged hyperon beam was produced by the 800 *GeV* proton beam in a copper target and was shaped in a narrow, 7 *m* long, channel in the magnet M1. The hyperon beam had the average momentum of 375 *GeV/c*, the momentum spread of ± 25 *Gev/c*, and the polarization of 12%. The measurements were performed at two opposite directions of the hyperon beam polarization vector (spin up and spin down), thus eliminating the contribution of the false asymmetry. The momenta of the protons and the hyperons were measured with the magnet spectrometers M1, M2 and M3 that contained the silicon microstrips detectors SD1-SD3 and the proportional chambers PWC1-PWC4. The missing mass resolution was

$$\sigma(M_x^2) = 0.0026\ GeV^2/c^4.$$

The photon spectrometer included the electromagnetic calorimeters LG1, LG2, and the transition radiation detector TRD. The calorimeters (LG1, LG2) measured the energy of the gammas. The coordinates of the gammas in the plane of the photon detector were precisely measured with the transition radiation detector developed at LNPI. The gammas produced electromagnetic showers in the steel convertor of the photon detector. The transition radiation effect enabled to register the most energetic charged component of the showers strongly oriented in the direction of the original gammas. The combination of the magnetic spectrometers, TRD, and the electromagnetic calorimeters provided reliable selection of the radiative decays from the background as seen from fig.2*a* and fig.2*b*.

As a result of the analysis of 34754 ± 212 events the following value for the asymmetry parameter was obtained [4]:

$$\alpha_\gamma = -0.720 +/-0.086(\text{stat}) +/-0.045(\text{syst}).$$

Thus the negative asymmetry in the radiative decay $\Sigma^+ \to p\gamma$ is now reliably established.

In parallel with this work, LNPI theorists developed a new approach based on the QCD sum rules, which was able to reproduce the big negative asymmetry in the $\Sigma^+ \to p\gamma$ decay [5]. Thus the long existing problem of the radiative hyperon decay $\Sigma^+ \to p\gamma$ can be considered as solved now.

References

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