# Proton–Lambda final state interaction

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The typical excess energy at COSY–11 is less than 10 MeV. In this range the interaction time is fairly long and the relative momenta of the outgoing particles are small (<100 MeV/c). Therefore, predominantly S-waves contribute to the reaction mechanism process. The theory of the energy dependence of the cross section is rather simple and the FSI can be extracted as the distortion of the simple phase space behaviour. Also the Coulomb interaction of the charged outgoing particles has to be taken into account. In this region the Watson modell [2] is valid: the energy dependence due to both the FSI and the Coulomb interaction can be separated from the reaction amplitude which is assumed to be constant.

In Jan. 97 the reaction pp $\rightarrow$ p $K^+\Lambda$ was measured at excess energies up to about 7 MeV [3]. To extract the total reaction cross section extensive acceptance calculations including FSI were performed. Only the FSI in the p–$\Lambda$ subsystem was taken into account being more than one order of magnitude stronger than in the other subsystems.

Close to threshold the FSI($q_{p\Lambda}$) depending on the relative CMS-momentum $q_{p\Lambda}$ of the outgoing p and $\Lambda$ is:

$$FSI(q_{p\Lambda}) = \frac{1}{q_{p\Lambda}^2 + (rq_{p\Lambda}^2/2 - 1/a)} \qquad (1)$$

with $a$ being the scattering length and $r$ the effective range parameter. Because the p$\Lambda$ system contains two S-wave states, namely $^1S_0$ and $^3S_1$, there are parameters $a_s$,$r_s$ and $a_t$,$r_t$ for the singlet and for the triplet states, respectively. Experimental evidence and theoretical calculations justify the assumption that both are equal in magnitude. Thus we used for the calculations the average of the parameters for both states ($\hat{a}$=($a_s$+$a_t$)/2, $\hat{r}$=($r_s$+$r_t$)/2).

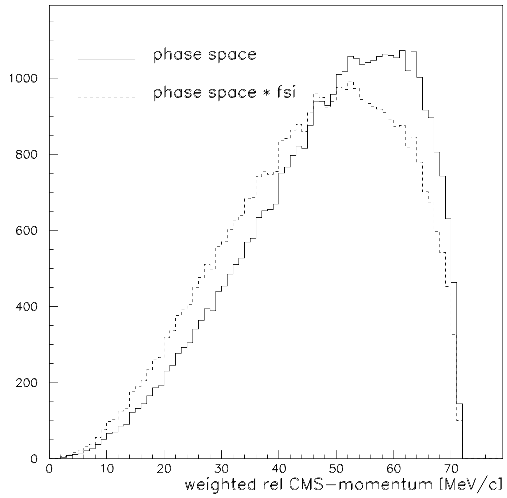


Figure 1: Relative momentum in the outgoing p–$\Lambda$ center of mass system

Figure 1 shows the distribution of $q_{p\Lambda}$ with and without FSI calculated using the Monte Carlo code "Geant". The FSI was included as a weight factor depending on $q_{p\Lambda}$ modifying the pure phase space momentum distribution.

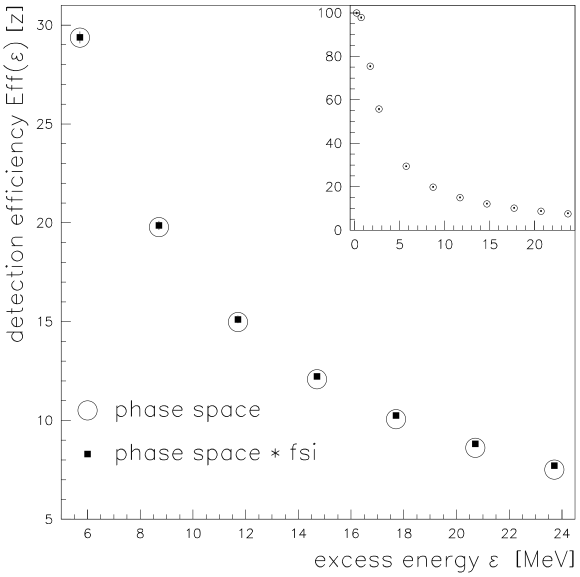


Figure 2: Acceptance of COSY-11 with and without p–$\Lambda$ final state interaction. For the exces energies lower $\epsilon = 5$ MeV the difference diminishes.

Figure 2 shows the detection efficiency obtained without kaon decay, no beam smearing and a point-like target. The FSI increases the detection efficiency with increasing excess energy sligthly. Still, at the highest examined excess energy the influence of the FSI to the detection efficiency is less than 3%. These calculations were done with average values for the scattering length and the effective range parameter taken from table 1 in ref. [4] (i.e. $\hat{a} = -1.7fm$, $\hat{r} = 3.fm$).

To demonstrate the non-dependence of different models we compared values for the scattering parameters chosen from experiments and theoretical models. In each studied case the FSI increased the detection efficiency by less than 3%.

**References:**

[1] S. Brauksiepe et al., Nucl. Instr. and Meth. A 376 (1996) 397

[2] K.M. Watson, Phys. Rev. 88 (1952) 1163

[3] J. Balewski et al., accepted by Phys. Lett. B

[4] J. Balewski et al., Phys. Lett. B 388 (1996) 859