

Effective range parameters in the $p - Y$ system extracted from the hyperon production data.

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Final state interactions of a two body subsystem in a 3-body final state like pK^+Y influence the excitation function in the threshold region and its analysis allows to extract information on the effective range parameters (for a review see ref. [1]). A parametrization of the cross section which relates the shape of the threshold behavior to the effective range parameters is e.g. given by Fäldt and Wilkin [2]:

$$\begin{aligned} \sigma &= \text{const} \cdot \frac{V_{ps}}{F} \cdot \frac{1}{\left(1 + \sqrt{1 + \frac{Q}{\varepsilon'}}\right)^2} \\ &= C' \cdot \frac{Q^2}{\sqrt{\lambda(s, m_p^2, m_p^2)}} \cdot \frac{1}{\left(1 + \sqrt{1 + \frac{Q}{\varepsilon'}}\right)^2}. \end{aligned} \quad (1)$$

The phase space volume V_{ps} and the flux factor F are given by [3]:

$$V_{ps} = \frac{\pi^3}{2} \frac{\sqrt{m_p m_{K^+} m_Y}}{(m_p + m_{K^+} + m_Y)^{\frac{3}{2}}} Q^2, \quad (2)$$

$$F = 2(2\pi)^{3n-4} \sqrt{\lambda(s, m_p^2, m_p^2)}. \quad (3)$$

with $\lambda(x, y, z) = x^2 + y^2 + z^2 - 2xy - 2yz - 2zx$.

The solid lines in fig. 1 represent the results of χ^2 fits using the Fäldt and Wilkin parametrization to the available data for the Λ and Σ^0 hyperon production in the close-to-threshold energy range up to ~ 60 MeV. The dashed lines correspond to the fit considering only pure S-wave phase space distributions.

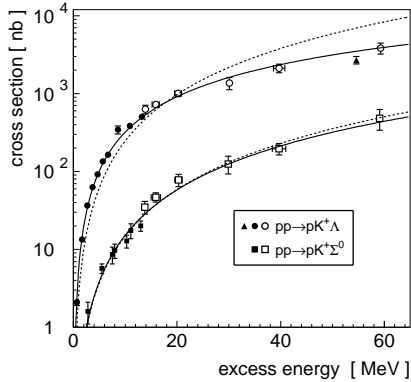


Fig. 1: Total cross sections for the $pp \rightarrow pK^+\Lambda$ and $pp \rightarrow pK^+\Sigma^0$ production (full symbols [4, 5], open symbols [6] and triangle [7]).

The parameter ε' , which is related to the strength of the $p - Y$ final state interaction and the normalization constant C' were extracted by the fits performed for each reaction separately resulting in:

$$\begin{aligned} C'(\Lambda) &= (98.2 \pm 3.7) \text{ nb/MeV}^2 \\ \varepsilon'(\Lambda) &= (5.51_{-0.52}^{+0.58}) \text{ MeV} \\ C'(\Sigma^0) &= (2.97 \pm 0.27) \text{ nb/MeV}^2 \\ \varepsilon'(\Sigma^0) &= (133_{-44}^{+108}) \text{ MeV}. \end{aligned}$$

Assuming only S-wave production, the $p - \Lambda(\Sigma^0)$ systems can be described using the Bergman potentials [8], where the scattering length \hat{a} and the effective range \hat{r} are given by:

$$\hat{a} = \frac{\alpha + \beta}{\alpha\beta}, \quad \hat{r} = \frac{2}{\alpha + \beta}, \quad (4)$$

with a shape parameter β and $\alpha = \pm \sqrt{\varepsilon' 2\mu}$ where μ is the reduced mass of the $p - Y$ system. The negative value of α is chosen since (at least for $p - \Lambda$) an attractive interaction is expected [9, 10].

The parameters \hat{a} and \hat{r} are interdependent and only a correlation between them can be deduced. In fig. 2 the correlations obtained for both the $p - \Sigma^0$ and for the $p - \Lambda$ systems are represented by the solid and dashed lines, respectively. The error ranges are shown in the figure by the thinner lines.

The results obtained for the $p - \Lambda$ system are consistent with the value of the spin averaged parameters determined experimentally [11] and shown in fig. 2 by the cross symbol.

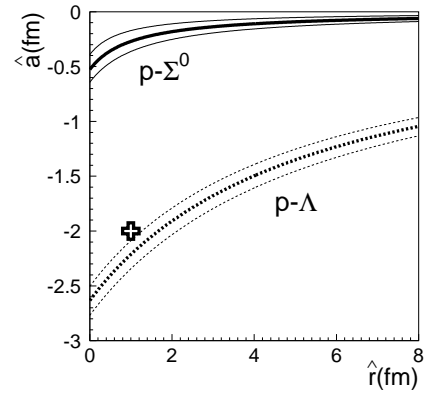


Fig. 2: Correlation between the $p - \Sigma^0$ (solid lines) and $p - \Lambda$ (dashed lines) effective range parameters. The cross symbol is the value of the $p - \Lambda$ effective range parameters extracted from a FSI approach in ref. [11].

It seems that the $p - \Sigma^0$ FSI is much smaller than the FSI for $p - \Lambda$. However, since transitions in the final state (like $n\Sigma^+ \rightarrow p\Sigma^0$) are possible, the use of the Fäldt and Wilkin parametrization allows only to obtain an estimation of the effective $N - \Sigma$ FSI and not directly the FSI in the $p - \Sigma^0$ channel [12]. Therefore, one should be careful when interpreting the result for the $p - \Sigma^0$ system.

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