$K - \pi$ Scattering

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The main source of our knowledge of kaon scattering amplitudes comes from kaon beam experiments at SLAC in the 1970s and 80s [1], [2]. The scattering amplitudes for πK final state were extracted from reactions using a proton target by extrapolating to small momentum transfer, t, dominated by nearly-on-shell pion exchange.

The following four reactions have been studied in different ranges of $|t'|$, where $t' = t - t_{min}$.

$$K^- p \to K^- \pi^+ n, \qquad I = 1/2, \tag{1}$$
$$K^+ p \to K^+ \pi^+ n, \qquad I = 3/2, \tag{2}$$
$$K^+ p \to K^+ \pi^- \Delta^{++}, \qquad I = 1/2, \tag{3}$$
$$K^- p \to K^- \pi^- \Delta^{++}, \qquad I = 3/2 \tag{4}$$

The single t bins were $-t' < 0.15$ GeV^2 for reactions (1), (2) and (4), while for reaction (3) the bin width was $-t' < 0.2$ GeV^2 [1].

Below we outline reactions that could be experimentally studied with K_L beam at proposed K_L Facility (KLF) at JLab on proton target:

$$K_L(K^0) p \to K^+ \pi^- p, \qquad I = 1/2, \tag{5}$$
$$K_L(\bar{K}^0) p \to K^- \pi^+ p, \qquad I = 1/2, \tag{6}$$
$$K_L(K^0) p \to K^+ \pi^+ \Delta^-, \qquad I = 3/2, \tag{7}$$
$$K_L(K^0) p \to K^0 \pi^+ n, \qquad I = 1/2, \tag{8}$$
$$K_L(\bar{K}^0) p \to \bar{K}^0 \pi^+ n, \qquad I = 3/2, \tag{9}$$
$$K_L(K^0) p \to K^+ \pi^0 \Delta^0, \qquad I = 1/2, \tag{10}$$
$$K_L(K^0) p \to K^+ \pi^0 n, \qquad I = 1/2, \tag{11}$$
$$K_L p(\bar{K}^0) \to K^- \pi^0 \Delta^{++}, \qquad I = 1/2 \tag{12}$$

The following reactions could be studied on a neutron target:

$$K_L(K^0) n \to K^+ \pi^- n, \qquad I = 1/2, \tag{13}$$
$$K_L(\bar{K}^0) n \to K^- \pi^+ n, \qquad I = 1/2, \tag{14}$$
$$K_L(\bar{K}^0) n \to K^- \pi^- \Delta^{++}, \qquad I = 3/2, \tag{15}$$
$$K_L(\bar{K}^0) n \to K^- \pi^0 \Delta^+, \qquad I = 1/2, \tag{16}$$
$$K_L(\bar{K}^0) n \to K^- \pi^+ \Delta^0, \qquad I = 1/2, \tag{17}$$
$$K_L(K^0) n \to K^0 \pi^0 n, \qquad I = 1/2, \tag{18}$$
$$K_L(K^0) p \to K^0 \pi^0 \Delta^0, \qquad I = 1/2, \tag{19}$$
$$K_L(K^0) n \to K^0 \pi^- p, \qquad I = 3/2. \tag{20}$$

The scattering amplitudes for πK final state should be extracted from reactions at pion pole by extrapolating to small momentum transfer, t, dominated by nearly-on-shell pion exchange.

From the current GlueX data on $\gamma + p \to K^{*0}(K^+\pi^-)\Sigma^+$ and $\gamma + p \to K^{*+}(K^+\pi^0)\Lambda^0$ we see that that data span up to t_{min} . For the proposal minimal task would be to simulate at least two reactions with $I = 1/2$ and $I = 3/2$ for example reaction (5) and (7) and show the t-distribution for few different ranges of $M_{K\pi}$. and estimate total number of events in each case for say $-t' < 0.1$ GeV^2. The this could be comapred to the SLAC data set.

More advanced simulation would be to perform partial wave analysis and extract the phase shifts for $S-$, and P-waves for $I = 1/2$ and $I = 3/2$ states.

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[1] P. Estabrooks*et al.*, Nucl. Phys. B **133**, 490 (1978).
[2] D. Aston *et al.*, Nucl. Phys. B **296**, 493 (1988).