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RADIATIVE CORRECTIONS IN FEW-BODY HADRONIC INTERACTIONS

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Following the method developed by M.R. Sogard¹, a general treatment for radiative corrections to any two-body hadronic reaction, $A + B \rightarrow C + D$, has been performed and applied to some specific collisions of pions, kaons and protons with nuclei at low and intermediate energies². In several cases, the results are found to be significant compared to the accuracies of available data.

The corrected experimental cross section is related to the measured one by the following expression :

$$\left. \frac{d\sigma}{ds} \right|_{\text{corr.}} = \left. \frac{d\sigma}{ds} \right|_{\text{meas.}} \cdot e^{\delta(\Delta E_3)}$$

ΔE_3 depends on the energy cut-off ($E_3^{\text{min.}}$), for detected particles :

$$\Delta E_3 = E_3(\hat{a}_{av}) - E_3^{\text{min.}}$$

and

$$\delta = \frac{\alpha}{\pi} \sum_{i=1}^4 \sum_{j=i}^4 s_{ij} z_i z_j T_{ij}$$

For $i=j$, the last term in the above expression is given by :

$$T_{ii} = \ln \left[2 \frac{p_i \cdot r}{x_{\text{max}}} \right],$$

and for $i \neq j$, by :

$$\begin{aligned} T_{ij} = \frac{p_i \cdot p_j}{2Q_{ij}} & \left\{ \ln \left[\frac{Q_{ij} - p_i \cdot (p_i - p_j)}{Q_{ij} + p_i \cdot (p_i - p_j)} \times \frac{Q_{ij} + p_j \cdot (p_i - p_j)}{Q_{ij} - p_j \cdot (p_i - p_j)} \right] \times \left[\ln \left(\frac{2p_i \cdot r}{x_{\text{max}}} \right) + \ln \left(\frac{2p_j \cdot r}{x_{\text{max}}} \right) \right] \right. \\ & + 2 \ln \left(\frac{u_{ij} - 1}{u_{ij}} \right) \times \ln |1 + c_{ij} u_{ij}| - 2 \ln \left(\frac{v_{ij} - 1}{v_{ij}} \right) \times \ln |1 + c_{ij} v_{ij}| \\ & + \ln \left(\frac{p_j \cdot r}{p_i \cdot r} \right) \left[\ln \left(\frac{u_{ij} - 1}{u_{ij}} \right) - \ln \left(\frac{v_{ij} - 1}{v_{ij}} \right) \right] \\ & \left. - 2 \left[\phi \left(\frac{u_{ij} - 1}{u_{ij} + 1/c_{ij}} \right) - \phi \left(\frac{u_{ij}}{u_{ij} + 1/c_{ij}} \right) - \phi \left(\frac{v_{ij} - 1}{v_{ij} + 1/c_{ij}} \right) + \phi \left(\frac{v_{ij}}{v_{ij} + 1/c_{ij}} \right) \right] \right\}. \end{aligned}$$

In table 1 the values of e^{δ} are given at $\theta_{lab} = 45^{\circ}$ and 135° , for some meson-light-nuclei reactions. With protons of up to 1 GeV, the correction is less than 1 %.

Table 1
Radiative corrections factor (e^{δ}), at $\theta_L = 45^{\circ}$ and 135°
and for $\Delta E_3 = 0.5$ MeV

Reaction	$T_{\pi}^L = 100$ MeV		$T_{\pi}^L = 300$ MeV	
	45°	135°	45°	135°
$\pi^+ p \rightarrow \pi^+ p$	1.01	1.02	1.02	1.03
$\pi^- p \rightarrow \pi^- p$	1.01	1.04	1.04	1.09
$\pi^- p \rightarrow \pi^0 n$	1.01	1.01	1.03	1.03
$\pi^+ d \rightarrow pp$	1.01	1.01	1.02	1.01
$\pi^+ {}^4\text{He} \rightarrow \pi^+ {}^4\text{He}$	1.01	1.03	1.03	1.05
$\pi^- {}^4\text{He} \rightarrow \pi^- {}^4\text{He}$	1.01	1.04	1.04	1.10
	$T_K^L = 500$ MeV		$T_K^L = 1000$ MeV	
$K^+ {}^4\text{He} \rightarrow K^+ {}^4\text{He}$	1.01	1.02	1.02	1.03
$K^- {}^4\text{He} \rightarrow K^- {}^4\text{He}$	1.02	1.08	1.05	1.14

REFERENCES

- 1) M.R. Sogard, Phys. Rev. D9 (1974) 1486.
- 2) B. Sagnai, CEN Saclay, Rapport Interne DPh-N/HE 2/83 (1983).

