epion.out

Manual for Pion Electroproduction $p(e, e'\pi^+)n$ for arXiv:1508.00969

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I. PROGRAM EXECUTION

For Liux user

- Execution command;

./epion.out

We relax cutoff masses for free parameters for user's convenience sake. (See table below for reproduction of arXiv:1508.00969.)

1. Input Λ_π
2. Input Λ_ρ
3. Input Λ_1

- Select (1)

For 4 differentials

1. Input energy W
2. Input momentum squared Q^2

- Select (2)

For $d\sigma_U/dt$

1. Input energy W
2. Input momentum squared Q^2
3. Input photon polarization ϵ_L

- Select (3)

For $2\pi d\sigma/dtd\phi$

1. Input energy W
2. Input momentum squared Q^2
3. Input photon polarization ϵ_L
4. Input momentum squared $-t$

II. DATA OUTPUT

dS_t.dat=Eq.(2) (See below)

dSU_t.dat=Eq.(3) (See below)

dSL_t.dat=$\frac{d\sigma_L}{dt}$

dST_t.dat=$\frac{d\sigma_T}{dt}$

dSTT_t.dat=$\frac{d\sigma_{TT}}{dt}$

dSLT_t.dat=$\frac{d\sigma_{LT}}{dt}$

III. MODEL FRAMEWORK

- The reaction process

$$\gamma^*(k) + p(p) \to \pi^+(q) + n(p') \tag{1}$$

- The sum of 4 differentials

$$2\pi \frac{d\sigma}{dt d\phi} = \frac{d\sigma_T}{dt} + \epsilon \frac{d\sigma_L}{dt} + \epsilon \frac{d\sigma_{TT}}{dt} \cos 2\phi + \sqrt{2\epsilon(\epsilon+1)} \frac{d\sigma_{LT}}{dt} \cos\phi \,, \tag{2}$$

- Unpolarized cross section

$$d\sigma_U = d\sigma_T + \epsilon d\sigma_L \tag{3}$$

- The production amplitude for

$$\mathcal{M}_{\pi^+} = \sqrt{2}\,(\mathcal{M}_{s,p} + \mathcal{M}_{t,\pi}) \times (t - m_\pi^2) \mathcal{R}^\pi(s,t) e^{-i\pi\alpha_\pi(t)} + \sqrt{2}\mathcal{M}_{t,\rho}\mathcal{R}^\rho(s,t)e^{-i\pi\alpha_\rho(t)} \tag{4}$$

with

$$i\mathcal{M}_{s,p} = e g_{\pi NN} \bar{u}_N(p') \gamma_5 \frac{(\not{p} + \not{k} + M_p)}{s - M_p^2} \widetilde{F}_1(Q^2) \not{\epsilon} u_N(p) \,, \tag{5}$$

$$i\mathcal{M}_{t,\pi} = e g_{\pi NN} \bar{u}_N(p') \widetilde{F}_\pi(Q^2) \frac{(2q-k)\cdot\epsilon}{t - m_\pi^2} \gamma_5 u_N(p), \tag{6}$$

$$i\mathcal{M}_{t,\rho} = -i g_{\gamma\rho\pi} g_{\rho NN} \bar{u}_N(p') F_\rho(Q^2) \epsilon^{\mu\nu\alpha\beta} \epsilon_\mu k_\nu q'_\alpha \left(\gamma_\beta + \frac{\kappa_\rho}{4m_p} [\gamma_\beta, \not{q}'] \right) u_N(p). \tag{7}$$

- Charge form factors

$$\widetilde{F}_1(Q^2)\not{\epsilon} = (F_1(k^2) - F_1(0)) \left(\not{\epsilon} - \not{k} \frac{k\cdot\epsilon}{k^2} \right) + F_1(0)\not{\epsilon}, \tag{8}$$

$$\widetilde{F}_\pi(Q^2)(2q-k)^\mu = (F_\pi(k^2) - F_\pi(0))(2q-k)\cdot \left(\epsilon - k\frac{k\cdot\epsilon}{k^2} \right) + F_\pi(0)(2q-k)\cdot\epsilon, \tag{9}$$

b

TABLE I. Physical constants for arXiv:1508.00969.

	mass [MeV]	cutoff [GeV]	cpl. const.
proton	938.272	Λ_1=1.55	-
π	139.57	Λ_π=0.65	$g_{\pi NN} = 13.4$
ρ	775.26	Λ_ρ=0.782	$g_{\gamma\rho\pi} = 0.22/\mathrm{GeV}$
			$g_{\rho NN} = 3.4$
			$\kappa_\rho = 6.1$

virtual photon momentum $Q^2 = -k^2$ and t-channel momentum transfer $q' = q - k$.

$$F_1(Q^2) = \left(\frac{1+\tau\mu_p}{1+\tau}\right)\left(1+\frac{Q^2}{\Lambda_1^2}\right)^{-2}, \tag{10}$$

$$F_\pi(Q^2) = \frac{1}{1+Q^2/\Lambda_\pi^2}, \tag{11}$$

$$F_\rho(Q^2) = \frac{1}{1+Q^2/\Lambda_\rho}, \tag{12}$$

where $\tau = Q^2/4M_P^2$ and proton magnetic moment $\mu_p = 2.793$ in the calculation.

- Regge pole and trajectories

$$\mathcal{R}^\varphi(s,t) = \frac{\pi\alpha'_\varphi}{\Gamma(\alpha_\varphi(t)+1-J)\sin\pi\alpha_\varphi(t)}\left(\frac{s}{s_0}\right)^{\alpha_\varphi(t)-J} \qquad (J=0 \text{ for } \pi,\ J=1 \text{ for } \rho) \tag{13}$$

$$\alpha_\pi(t) = 0.7(t - m_\pi^2), \tag{14}$$

$$\alpha_\rho(t) = 0.8t + 0.5. \tag{15}$$

\- The End -