# Evaluation of the starting values of hybrid baryon electrocouplings $A_{1/2}(Q^2)$, $A_{3/2}(Q^2)$, $S_{1/2}(Q^2)$ for the simulation of $KY$ exclusive electroproduction events off protons.

1. Objective: Determine the values of $A_{1/2}$, $A_{3/2}$, $S_{1/2}$ hybrid electrocouplings at different $Q^2$ above which signal from hybrid baryon will be detected with the CLAS12

2 Hybrid parameters:

Spin/Parity: $1/2^+$, $3/2^+$

Mass : $M_H = 2.20$ GeV

(1) Full decay widths: $\Gamma_H = 0.25$ GeV

$\Gamma(H \to KY)$ according Eq (9) p.27 of LOI

$$\Gamma(H \to KY) = \Gamma_{\gamma t} = \frac{1}{2}\, 0.25 \cdot 0.05 = 0.00625 \text{ GeV}$$

The values of $A_{1/2}$, $A_{3/2}$, $S_{1/2}$ electro-couplings of hybrid baryon above which the hybrid state will be detected with the CLAS12 should be determined at the grid of $Q^2$:

(2) $Q^2$: 0.05, 0.20, 0.40, 0.60, 0.8, 1.0 $GeV^2$

For hybrid of $3/2^+$, $1/2^+$ they should be determined varying single parameter $A$ of Eq. (11) p. 28 of LOI

For the hybrid of $1/2^+$ in addition, electrocouplings should be determined varying $A_{1/2}$ with $S_{1/2} = 0$.

3. <u>How to ~~determ~~ estimate the start values for $A_{1/2}$, $A_{3/2}$, $S_{1/2}$ before the event simulation</u>

For different values of parameter $A$ ($A_{1/2}$, $S_{1/2} = 0$ for $J^\pi = 1/2^+$) compute unpolarized differential cross sections $d\sigma/d(-\cos\theta_K)_0$ without hybrid and

$d\sigma / d(-\cos\theta_K)_H$ with hybrid contribution

$$\frac{d\sigma}{d(-\cos\theta_K)_{0,H}} = \frac{d\sigma}{d\Omega_{K\,0,H}} \cdot 2\pi \qquad (3)$$

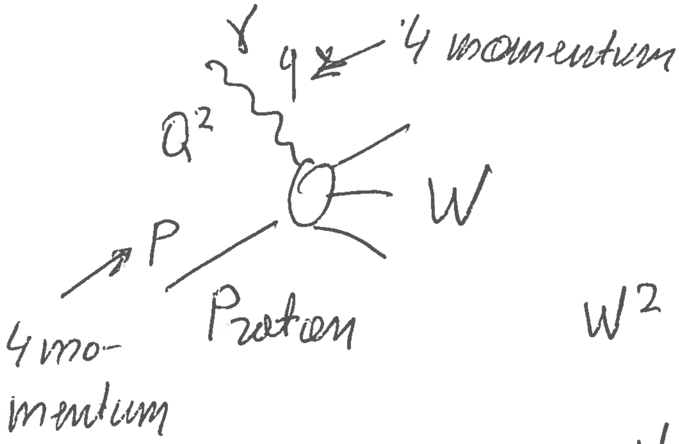
$$\frac{d\sigma}{d\Omega_{K\,0,H}} = \frac{d\sigma_T}{d\Omega_{K\,0,H}} + \varepsilon_L \frac{d\sigma_L}{d\Omega_{K\,0,H}} \qquad (4)$$

Two terms in Eq (4) can be evaluated both in JM or (Ghent) conventions employing the transformation factors for the non-resonant Ghent → JM (resonant JM → Ghent) amplitudes.

## 3a. Evaluation of $\varepsilon_L$

Should be done according to Eq (14), Eq (20) of LOI in pp. 29 and 30, respectively.

$tg\frac{\theta_e}{2}$ and $\nu$ should be derived from the values of $W$ and $Q^2$ and the initial electron beam energy $E_b$ as:




$$\nu = \frac{qP}{M_N}$$

$$W^2 = (q+P)^2 = -Q^2 + M_N^2 + 2M_N\nu$$

$$\nu = \frac{W^2 + Q^2 - M_N^2}{2M_N} \quad (5)$$

$$Q^2 = 4E_b(E_b - \nu)\sin^2\frac{\theta_e}{2}$$

$$\sin^2\frac{\theta_e}{2} = \frac{Q^2}{4E_b(E_b-\nu)} \quad (6)$$

$$\cos^2\frac{\theta_e}{2} = \left(1 - \sin^2\frac{\theta_e}{2}\right) \quad (7)$$

$$tg^2\frac{\theta_e}{2} = \frac{Q^2}{4E_b(E_b-\nu)\left(1 - \frac{Q^2}{4E_b(E_b-\nu)}\right)} =$$

$$= \frac{Q^2}{4E_b(E_b-\nu) - Q^2} \quad (8)$$

$E_b = 11$ GeV

## 3b. Cross section grid and uncertainties

The differential cross sections (4) should be evaluated at each $Q^2$ of (2) at W grid

(9) W: 2.0, 2.1, 2.15, 2.20, 2.25, 2.30, 2.50 GeV

(10) ~~in θ~~ in 10 equal bins over $\theta_K$ from 0 to 180°

The $\chi^2/d.p.$ for the ~~cross diff~~ difference of differential cross sections computed with/without hybrid should be evaluated as:

$$\chi^2/d.p. = \frac{1}{N_{d.p.}} \sum_{W_i,\theta_j} \frac{\left[ \frac{d\sigma}{d(-\cos\theta_K)_H} - \frac{d\sigma}{d(-\cos\theta_K)_0} \right]^2}{\delta^2_{i,j}} \quad (11)$$

at any given $Q^2$

the sum is running over all bins of W, and $\theta_K$ Eqs (2, 9, ) at given $Q^2$. $N_{d.p}$ stands for the total number of the data points at given $Q^2$

$$\delta_{i,j} = \sqrt{\delta_H^2 + \delta_0^2} \quad (12)$$

$$\delta_H = \frac{d\sigma}{d(-\cos\theta_K)}_H \cdot \varepsilon_{dat} \quad (13)$$

$$\delta_0 = \frac{d\sigma}{d(-\cos\theta_K)_0} \cdot \varepsilon_{dat} \quad (14)$$

The cross section uncertainties

$$\varepsilon_{dat} = \begin{cases} 5\% & \text{for } K\Lambda \\ 10\% & \text{for } K\Sigma \end{cases}$$

Varying paramet $A$ of Eq (11) of LOI (or $A_{1/2}$, $S_{1/2}=0$ for $J^\pi = 1/2^+$, in addition) in each bin of $Q^2$ of (9) at write-up independently to determine $A$-value at which $\chi^2/d.p. > 2.0$

The minimal values $A_{1/2}(Q^2)$, $A_{3/2}(Q^2)$ $S_{1/2}(Q^2)$ can be computed from $A$ (or $A_{1/2}$ determined directly for $J^\pi = 1/2^+$ [illegible])