

I. EXTRACTION OF THE HYBRID STATE PARAMETERS FROM THE DATA

An attempt was performed to test the possibility of the extraction of the baryon state parameters from the data. The RPR model with one additional resonance (see section ??) was used to simulate the quasi-data cross sections $\frac{d\sigma}{d\Omega_{K^+}}$ in the grid over W from 1.6 to 2.7 GeV. We used 20 data points over both $\cos(\theta_{K^+})$ and ϕ_{K^+} . The W bin width was 50 MeV and $Q^2 = 0.5 \text{ GeV}^2$. The resonance parameters: spin J_R ($\frac{1}{2}$ or $\frac{3}{2}$), mass M_R , electrocoupling $A_{1/2}$ and the total width Γ_{tot} were unknown. In this attempt we did not include electrocouplings $S_{1/2}$ and $A_{3/2}$ in the list of the resonance parameters and set them to zero. We tried to extract the parameters in the fit of “model plus resonance” cross sections to the quasi-data. The minimum of

$$\tilde{\chi}^2 = \sum_{W, \theta_{K^+}, \phi_{K^+}} \left(\frac{d\sigma_{data}}{d\Omega_{K^+}} - \frac{d\sigma_{fit}}{d\Omega_{K^+}} \right)^2 \quad (1)$$

was searched when fitting, where indices *data* and *fit* stand for the quasi-data and the fitting cross sections.

There is a number of available fitting programs such as *minuit* from CERN, though at the initial step the very simple fitting algorithm was used. The fitting procedure is as follows: a) set $A_{1/2}$ and Γ_{tot} to certain medium (arbitrary) values, say $A_{1/2} = 0.04 \text{ GeV}^{-1/2}$ and $\Gamma_{tot} = 0.2 \text{ GeV}$; b) vary M_R to find the minimum of $\tilde{\chi}^2$; c) set M_R to the value found in the previous step and vary $A_{1/2}$ to find the minimum of $\tilde{\chi}^2$; d) set $A_{1/2}$ to the value found in the previous step and vary Γ_{tot} to find the minimum of $\tilde{\chi}^2$; e) set Γ_{tot} to the value found in the previous step. Then the procedure was iterated starting from the step b). This algorithm was employed twice under assumptions about the resonance spin $\frac{1}{2}$ and $\frac{3}{2}$. Only three iteration of the fitting procedure was needed to determine the values of the resonance parameters with an accuracy of about few percent in the case when J_R was set to the correct value. If the spin was wrong, then the minimal value of $\tilde{\chi}^2$ was several times larger than in was in the first case and the found parameters was significantly different from the true values, also they could be non-realistic. For instance, the found Γ_{tot} was 20 MeV.

Fig. ?? illustrates the fitting procedure when the spin of the resonance was set to the correct value. The red line in the figure corresponds to the first iteration and shows the value proportional to $\tilde{\chi}^2/\text{d.p.}$ calculated at the running resonance mass. The black line corresponds to the last iteration. The figure demonstrates that when using the wrong values $A_{1/2} = 0.04 \text{ GeV}^{-1/2}$ and $\Gamma_{tot} = 0.2 \text{ GeV}$ the value of $M_R = 2.22 \text{ GeV}$ corresponding to the the minimum of $\tilde{\chi}^2/\text{d.p.}$ is not correct, though it is close to the true value 2.3 GeV. Thus, the resonance parameters cab be reliably extracted employing the fit.

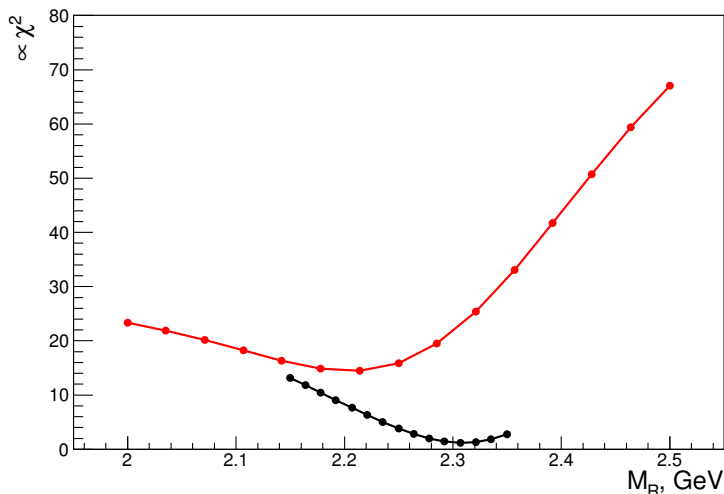


FIG. 1: The $\tilde{\chi}^2/\text{d.p.}$ dependencies evaluated from comparison between the quasi-data and the “model + resonance” cross sections computed with a running resonance mass at $Q^2 = 0.5 \text{ GeV}^2$. Red line corresponds to the first iteration of the fit (see text), when the other fit parameters were set to the arbitrary values $A_{1/2} = 0.040 \text{ GeV}^{-1/2}$ and $\Gamma_{tot} = 0.20 \text{ GeV}$. Black line corresponds to the last iteration of the fit, when $A_{1/2} = 0.042 \text{ GeV}^{-1/2}$ and $\Gamma_{tot} = 0.26 \text{ GeV}$ and these values are supposed to be close to the true values. The true M_R was 2.3 GeV and it was extracted with the accuracy of few percent.