Измерение форматора распада $\Lambda_c \to \Lambda l \nu_l$

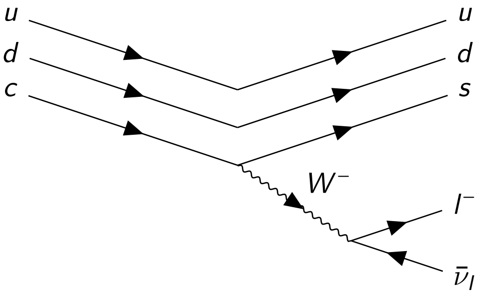
Карибджанов Матвей, Пахлов Павел

13 ноября 2024 г.

Мотивация

- Уточнение результата CLEO. Improved measurement of the form-factors in the decay $\Lambda_c^+ \to \Lambda e \nu_e$ J. W. Hinson et al. // Phys. Rev. Lett. — 2005. — Vol. 94. — Iss. 19, 191801. — 5 p.
- Проверка моделей HQET, LQCD проедсказывающие формфакторы распада $\Lambda_c \to \Lambda$.

Теория



$$\langle B_{\Lambda_c} | j^V_\nu | B_\Lambda \rangle = u^\dagger_\Lambda \left(\mathfrak{F}^V_1 \left(q^2\right) \gamma_\nu + \frac{\mathfrak{F}^V_2}{M_{\Lambda_c}} \left(q^2\right) \sigma_{\mu\nu} q^\nu + \frac{\mathfrak{F}^V_3}{M_{\Lambda_c}} \left(q^2\right) q_\mu \right) u_{\Lambda_c}$$

$$\langle B_{\Lambda_c} | j^A_\nu | B_\Lambda \rangle = u^\dagger_\Lambda \left(\mathfrak{F}^A_1 \left(q^2\right) \gamma_\nu + \frac{\mathfrak{F}^A_2}{M_{\Lambda_c}} \left(q^2\right) \sigma_{\mu\nu} q^\nu + \frac{\mathfrak{F}^A_3}{M_{\Lambda_c}} \left(q^2\right) q_\mu \right) \gamma_5 u_{\Lambda_c}$$

Теория

$$H_{\lambda_\Lambda \lambda_w} = H^V_{\lambda_\Lambda \lambda_w} + H^A_{\lambda_\Lambda \lambda_w}$$

$$H^{V,A}_{\lambda_\Lambda \lambda_w} = \langle B_{\Lambda_c}\left(p_{\Lambda_c}, M_{\Lambda_c}\right) | j^{V,A}_\nu | B_\Lambda\left(p_\Lambda, M_\Lambda\right)\rangle \varepsilon^\nu\left(\lambda_w\right)$$

Часть итоговой системы уравнений (для векторной части):

$$H^V_{\frac{1}{2}t} = \frac{\sqrt{Q_+}}{\sqrt{q^2}}\left(F^V_1\left(M_{\Lambda_c} - M_\Lambda\right) + F^V_3 \frac{q^2}{M_{\Lambda_c}}\right),$$

$$H^V_{\frac{1}{2}1} = \sqrt{2Q_-}\left(-F^V_1 - F^V_2 \frac{M_{\Lambda_c} + M_\Lambda}{M_{\Lambda_c}}\right),$$

$$H^V_{\frac{1}{2}0} = \frac{\sqrt{Q_-}}{\sqrt{q^2}}\left(F^V_1\left(M_{\Lambda_c} + M_\Lambda\right) + F^V_2 \frac{q^2}{M_{\Lambda_c}}\right),$$

Отбор событий

$$e^+e^- \to \Lambda_c^- X_c^+$$

$$X_c^+ \to D^0 p;\ \ D^+ p\pi^-; D^{*0} p;\ \ D^{*+} p\pi^-$$

$$D^+ \to K^-\pi^+\pi^+;\quad K_S\pi^+;\ \ K_S\pi^+\pi^+\pi^-;\quad K^+K^-\pi^+$$

$$D^0 \to K^-\pi^+; K_S\pi^0\quad K^-\pi^+\pi^+\pi^-;\ \ K^-\pi^+\pi^0\quad K^-K^+;\ \ K_S\pi^+\pi^-$$

$$D^{*0} \to D^0\pi^0$$

$$D^{*+} \to D^0\pi^+;\ \ D^+\pi^0$$

Тагирование Λ_c

$$\mathfrak{L}(a/b) = \frac{L_a}{L_b + L_a}$$

- $\mathfrak{L}\left(K/\pi, K/p\right) > \{0.6, 0.6\}$
- $\mathfrak{L}\left(p/\pi, p/K\right) > \{0.6, 0.4\}$
- $dz_K < 2cm; dr_K < 0.5cm$
- $dz_p < 2cm; dr_p < 0.5cm$
- $dz_\pi < 2cm; dr_\pi < 0.5cm$
- $E_\gamma > 50MeV$
- $goodBelleKshort = 1$

- $\left|M_{\pi^0} - M_{\pi^0}^{real}\right| < 15MeV$
- $\left|M_{K_S} - M_{K_S}^{PDG}\right| < 15MeV$
- $\left|M_D - M_D^{PDG}\right| < 15MeV$
- $\left|M_{D^*} - M_{D^*}^{PDG}\right| < 2MeV$

GoodBelleKshort

Table 1. The goodKs cuts

Momentum(Gev)	dr(cm)	$d\phi$(rad.)	z_dist(cm)	fl(cm)
< 0.5	> 0.05	< 0.3	< 0.8	$-$
$0.5 - 1.5$	> 0.03	< 0.1	< 1.8	> 0.08
> 1.5	> 0.02	< 0.03	< 2.4	> 0.22

FIG. 1: GoodK_S^0 variables and their selection.

Bin	ϵ_{sig} (%)	bkg rejection (%)	ϵ_{sig} (%)	bkg rejection (%)	ϵ_{sig} (N. Dash) BN 1373
1	68.6 ± 0.0	99.3 ± 0.1	57.6 ± 0.0	97.8 ± 0.1	69.3 ± 0.9
2	83.0 ± 0.0	99.4 ± 0.1	76.0 ± 0.0	98.0 ± 0.1	85.2 ± 0.3
3	86.0 ± 0.1	99.5 ± 0.5	80.5 ± 0.1	98.7 ± 0.3	83.9 ± 0.2
Total	78.1 ± 0.0	99.4 ± 0.1	70.7 ± 0.0	98.0 ± 0.1	83.7 ± 0.2

TABLE I: GoodK_S^0 selection efficiency from BGx0 and BGx1 samples.

Тагирование Λ_c

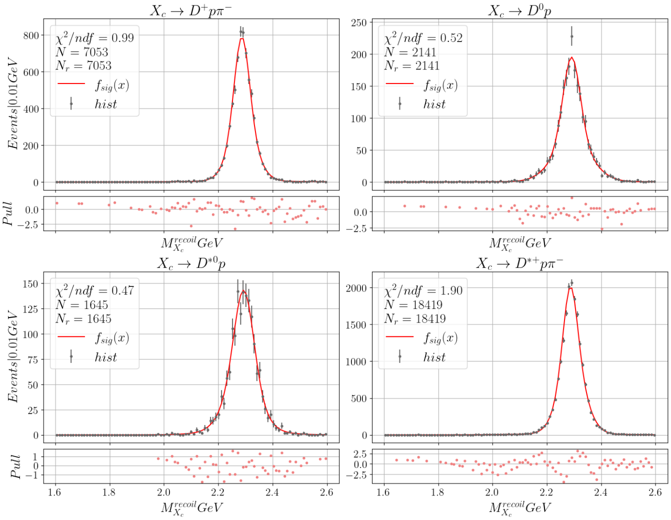
$$F(x, args) = f_{\text{continuum}} + f_{\text{signal}} + f_{\text{back ground}} \tag{1}$$

$$f_{\text{continuum}}(x) = \exp\left(\frac{x-\mu}{\lambda}\right) + a_0 + a_1 \cdot x \tag{2}$$

$$f_{\text{signal}}(x) = G(x; M_{\Lambda_c}, \sigma_1) + G(x; \mu_2, \sigma_2) + G(x; \mu_3, \sigma_3) \tag{3}$$

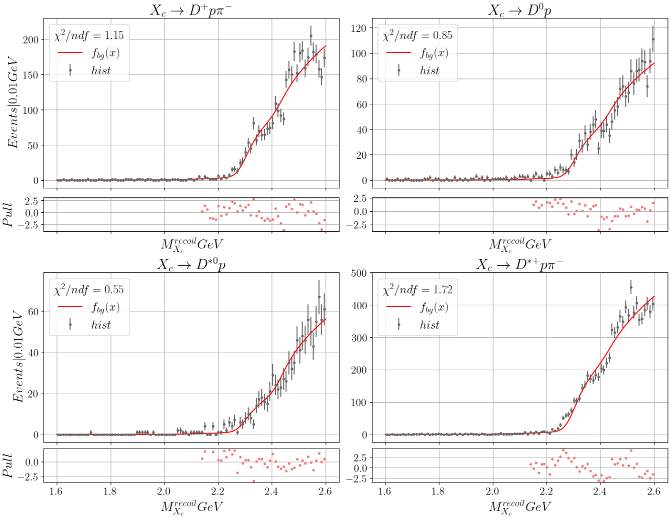
$$f_{\text{back ground}} = f_{\text{signal}}(x) \circledast \left(\sqrt{x - M_\pi} \cdot \theta\left(x - M_\pi\right) \cdot c_1 + \sqrt{x} \cdot \theta\left(x\right) \cdot c_2\right) \tag{4}$$

Тагирование Λ_c на MC



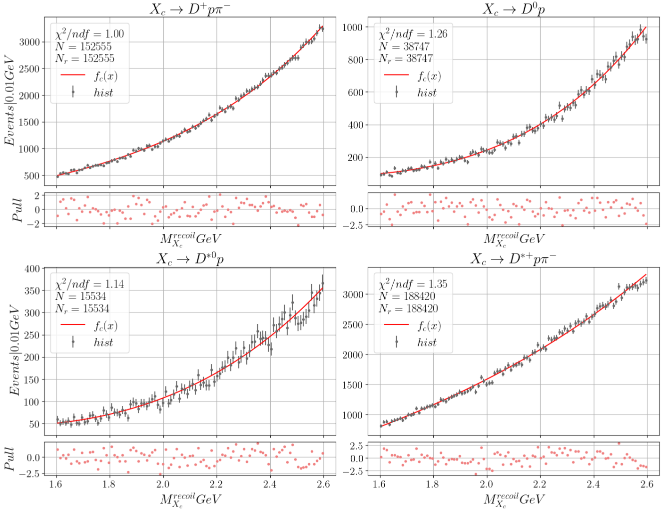
$$f_{\text{signal}}(x) = G(x; M_{\Lambda_c}, \sigma_1) + G(x; \mu_2, \sigma_2) + G(x; \mu_3, \sigma_3)$$

Тагирование Λ_c на МС



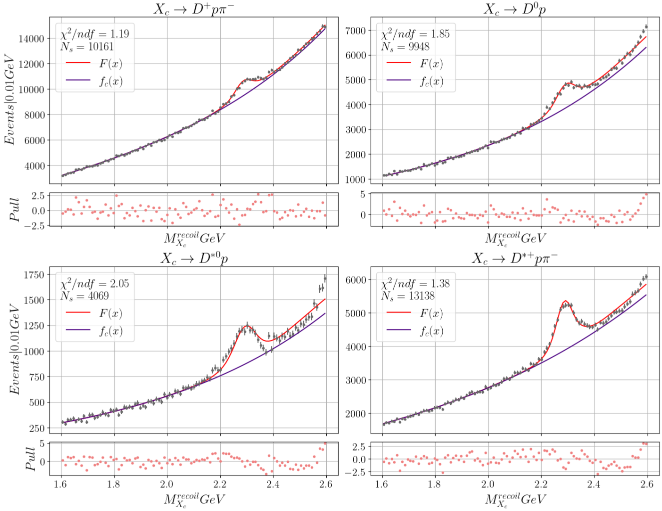
$$f_{\text{back ground}} = f_{\text{signal}}(x) \circledast \left(\sqrt{x - M_\pi} \cdot \theta\left(x - M_\pi\right) \cdot c_1 + \sqrt{x} \cdot \theta\left(x\right) \cdot c_2\right)$$

Тагирование Λ_c на MC



$$f_{\text{continuum}}(x) = \exp\left(\frac{x-\mu}{\lambda}\right) + a_0 + a_1 \cdot x$$

Тагирование Λ_c на Data



$$F(x, args) = f_{\text{continuum}} + f_{\text{signal}} + f_{\text{back ground}}$$

Сравнение с С. Приваловым