



- Analysis of process: $\Lambda \rightarrow pe^-\bar{\nu}_e$, $\Xi^- \rightarrow \Lambda e^-\bar{\nu}_e$
- Extraction of FFs using provided by modular method [[VB,AKupsc,et al., PRD108\(2023\)016011](#)]



- Analysis of process: $\Lambda \rightarrow pe^- \bar{\nu}_e$, $\Xi^- \rightarrow \Lambda e^- \bar{\nu}_e$
- Extraction of FFs using provided by modular method [[VB, AKupsc, et al., PRD108\(2023\)016011](#)]
- Joint angular distribution of SLHDs
 - $B_1 \rightarrow B_2 e^- \bar{\nu}_e$ - polarization of B_2 is not measured: $\Lambda \rightarrow pe^- \bar{\nu}_e$
 - $B_1 \rightarrow B_2 (\rightarrow B_3 \pi^-) e^- \bar{\nu}_e$ - polarization of B_2 is measured:
 $\Xi^- \rightarrow \Lambda (\rightarrow p \pi^-) e^- \bar{\nu}_e$

Joint angular distribution for Λ SLD (1)



- $B_1 \rightarrow B_2 e^- \bar{\nu}_e$ - polarization of B_2 is not measured: $\Lambda \rightarrow p e^- \bar{\nu}_e$
- $d\Gamma \propto \mathcal{W} = V_{Ph}(q^2)(q^2 - m_e^2)\text{Tr}\rho_p$

$$\text{Tr}\rho_p \propto \sum_{\mu=0}^3 C_{\mu 0} \mathcal{B}_{\mu 0}^{\Lambda p} = \sum_{\mu=0}^3 C_{\mu 0} \sum_{\kappa=0}^3 \mathcal{R}_{\mu\kappa}^{(4)}(\Omega_p) b_{\kappa 0}^{\Lambda p}(q^2, \Omega_e)$$

- $C_{\mu 0} = (1, P_x, P_y, P_z)$ - polarization vector
- $V_{Ph}(q^2) = (2\pi)^{-5} (4M_1)^{-2} |\vec{p}_e| |\vec{p}_p|$ - 3-body PHSP density factor
[\[PDG2024\]](#)
- $\mathcal{R}_{\mu\kappa}^{(4)}(\Omega_p)$ - 4×4 space-like rotation matrix
- $b_{\kappa 0}^{\Lambda p}(q^2, \Omega_e) \equiv b_{\kappa 0}(q^2, \Omega_e; \text{FFs})$ - elements of decay matrix

Joint angular distribution for Λ SLD (2)



$$\mathcal{W}(\boldsymbol{\xi}; \boldsymbol{\omega}) = V_{Ph}(q^2)(q^2 - m_e^2)[b_{00}(q^2, \Omega_e; \text{FFs}) + P_z b_{30}(q^2, \Omega_e; \text{FFs}) \cos \theta_p]$$

- $\boldsymbol{\xi} = (\theta_p, \phi_p, q^2, \theta_e)$ - complete set of kinematic variables
- $\boldsymbol{\omega} = (\text{FFs})$ with

$$g_{av}(0) = \frac{g_1(0)}{f_1(0)}, \quad g_{av}(0) = \frac{f_2(0)}{f_1(0)}, \quad g_{av2}(0) = \frac{g_2(0)}{f_1(0)}$$

where f_i - vector FFs and g_i - axial-vector FFs



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- $d\Gamma \propto \mathcal{W}(\boldsymbol{\xi}; \boldsymbol{\omega}) = V_{Ph}(q^2)(q^2 - m_e^2)\text{Tr}\rho_p$

$$\text{Tr}\rho_p \propto \sum_{\mu,\nu=0}^3 C_{\mu 0} \mathcal{B}_{\mu\nu}^{\Xi\Lambda} a_{\nu 0}^{\Lambda p} = \sum_{\mu=0}^3 C_{\mu 0} \sum_{\kappa,\nu=0}^3 \mathcal{R}_{\mu\kappa}^{(4)}(\Omega_\Lambda) b_{\kappa\nu}^{\Xi\Lambda}(q^2, \Omega_e) a_{\nu 0}^{\Lambda p}(\Omega_p)$$

- $b_{\kappa\nu}^{\Xi\Lambda}(q^2, \Omega_e) \equiv b_{\kappa\nu}(q^2, \Omega_e; \text{FFs})$ - elements of SL decay matrix
- $a_{\nu 0}^{\Lambda p}(\Omega_p) \equiv a_{\nu 0}(\Omega_p; \alpha_\Lambda)$ - elements of non-leptonic decay matrix



- $B_1 \rightarrow B_2(\rightarrow B_3\pi^-)e^-\bar{\nu}_e$ - polarization of B_2 is measured:
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$$\text{Tr}\rho_p \propto \sum_{\mu,\nu=0}^3 C_{\mu 0} \mathcal{B}_{\mu\nu}^{\Xi\Lambda} a_{\nu 0}^{\Lambda p} = \sum_{\mu=0}^3 C_{\mu 0} \sum_{\kappa,\nu=0}^3 \mathcal{R}_{\mu\kappa}^{(4)}(\Omega_\Lambda) b_{\kappa\nu}^{\Xi\Lambda}(q^2, \Omega_e) a_{\nu 0}^{\Lambda p}(\Omega_p)$$

- $b_{\kappa\nu}^{\Xi\Lambda}(q^2, \Omega_e) \equiv b_{\kappa\nu}(q^2, \Omega_e; \text{FFs})$ - elements of SL decay matrix
- $a_{\nu 0}^{\Lambda p}(\Omega_p) \equiv a_{\nu 0}(\Omega_p; \alpha_\Lambda)$ - elements of non-leptonic decay matrix
- $\boldsymbol{\xi} = (\theta_\Lambda, \phi_\Lambda, q^2, \theta_e, \theta_p, \phi_p)$ - complete set of kinematic variables
- $\boldsymbol{\omega} = (\alpha_\Lambda, \text{FFs})$ with $\alpha_\Lambda = 0.746 \pm 0.008$ [PDG2024]

Our contribution to BESIII analyses



- Development of modular approach to measure FFs
- Implication via mDIY function of BesEvtGen generator

```
Decay J/psi
1 Lambda0 anti-Lambda0 PHSP;
Enddecay

Decay Lambda0
1 p+ e- anti-nu_e PHSP;
Enddecay

Decay anti-Lambda0
1 anti-p+ pi+ PHSP;
Enddecay

End
*////////
//-----
EvtVector4R vpho,lambda,lambdaBar,proton,wBoson,electron,antineu,antiproton;
lambda = part->getDaug(0)->getP4(); //lambda momentum
lambdaBar= part->getDaug(1)->getP4(); //anti-Lambda momentum
proton = part->getDaug(0)->getP4(); //proton momentum
electron = part->getDaug(0)->getDaug(1)->getP4(); //electron momentum
antineu = part->getDaug(0)->getDaug(2)->getP4(); //electron anti-neutrino momentum
antiproton= part->getDaug(1)->getDaug(0)->getP4(); //anti-proton momentum

wBoson = electron + antineu; //W-boson momentum
vpho = lambda+lambdaBar; //Jpsi momentum

EvtVector4R bm,bel,bnu;
bm=1*wBoson; bm.set(0,wBoson.get(0));
bnu=boostTo(antineu,bm);
bel=boostTo(electron,bm);

// Eleven angular functions
double F0 = 1;
double F1 = pow(cos(theta),2);
double F2 = -pow(cos(theta),2)*cos(theta1)*cos(theta2) + pow(sin(theta),2)*cos(phi1)*cos(phi2)*sin(theta1)*sin(theta2);
double F2p = -pow(cos(theta),2)*sin(theta1)*cos(theta2) - pow(sin(theta),2)*cos(phi1)*cos(phi2)*cos(theta1)*sin(theta2);
double F3 = -cos(theta1)*cos(theta2) + pow(sin(theta),2)*sin(phi1)*sin(phi2)*sin(theta1)*sin(theta2);
double F3p = -sin(theta1)*cos(theta2) - pow(sin(theta),2)*sin(phi1)*sin(phi2)*cos(theta1)*sin(theta2);
double F4 = cos(theta)*sin(theta)*cos(phi1)*cos(theta2)*sin(theta1) - cos(phi2)*cos(theta1)*sin(theta2);
double F4p = -cos(theta)*sin(theta)*cos(phi1)*cos(theta2)*cos(theta1) + cos(phi2)*sin(theta1)*sin(theta2);
double F5 = sin(theta)*cos(theta)*sin(phi1)*sin(theta1);
double F5p = sin(theta)*cos(theta)*sin(phi1)*cos(theta1);
double F6 = sin(theta)*cos(theta)*sin(phi2)*sin(theta2);

amps = (F0 + alpha*F1 +
als1*alphaLb*(F2 + alpha*F3 + sqrt(1 - pow(alpha,2))*cos(Delta)*F4) +
1Ls1*alphaLb*(F2p + alpha*F3p + sqrt(1 - pow(alpha,2))*cos(Delta)*F4p) +
sqrt(1 - pow(alpha,2))*sin(Delta)*(als1*F5 + alphaLb*F6 + 1Ls1*F5p))*sigmaLs1;
```