Form factors for $\Lambda_b \to \Lambda_c^* \ell \nu$

Marcin Chrząszcz
Nicola Serra
Elena Graverini

University of Zurich[UZH]

$R(\Lambda_c^*)$ meeting, CERN
February 5, 2016

Introduction

The matrix elements for our Λ_b decays are depended on $F_{1,..,4}$ and $G_{1,...,4}$ form factors:

$$\langle \Lambda_c^{1/2^-}(p',s')|V_\mu|\Lambda_b(p,s)\rangle = \overline{u}(p',s')\left(F_1(q^2)\gamma_\mu + F_2(q^2)\frac{p_\mu}{m_{\Lambda_Q}} + F_3(q^2)\frac{p'_\mu}{m_{\Lambda_q}}\right)u(p,s),$$

$$\langle \Lambda_c^{1/2^-}(p',s')|A_\mu|\Lambda_b(p,s)\rangle = \overline{u}(p',s')\left(G_1(q^2)\gamma_\mu + G_2(q^2)\frac{p_\mu}{m_{\Lambda_Q}} + G_3(q^2)\frac{p'_\mu}{m_{\Lambda_q}}\right)\gamma_5 u(p,s),$$

$$\langle \Lambda_c^{3/2^-}(p',s')|V_\mu|\Lambda_b(p,s)\rangle = \overline{u}^\alpha(p',s')\left[\frac{p_\alpha}{m_{\Lambda_Q}}\left(F_1\gamma_\mu + F_2\frac{p_\mu}{m_{\Lambda_Q}} + F_3\frac{p'_\mu}{m_{\Lambda_q^{3/2}}}\right) + F_4 g_{\alpha\mu}\right]u(p,s),$$

$$\langle \Lambda_c^{3/2^-}(p',s')|A_\mu|\Lambda_b(p,s)\rangle = \overline{u}^\alpha(p',s')\left[\frac{p_\alpha}{m_{\Lambda_Q}}\left(G_1\gamma_\mu + G_2\frac{p_\mu}{m_{\Lambda_Q}} + G_3\frac{p'_\mu}{m_{\Lambda_q^{3/2}}}\right) + G_4 g_{\alpha\mu}\right]\gamma_5 u(p,s)$$

What is in the simulation?

$\Rrightarrow$ The simulation that we have uses the form factors calculated in arXiv:nucl-th/0503030

$\Rrightarrow$ In this paper the form factors are calculated in constituent quark model.

$\Rrightarrow$ Let me quote a theorists that wants to remain anonymous: „it's not even wrong".

$\Rrightarrow$ Never the less this is what Syracuse is using and is now in the simulation $\longrightarrow$ we will reweigh our MC.

$\Rrightarrow$ To do so, we firstly looked at reproducing the calculations from `EvtGen`.

Form factor calculus

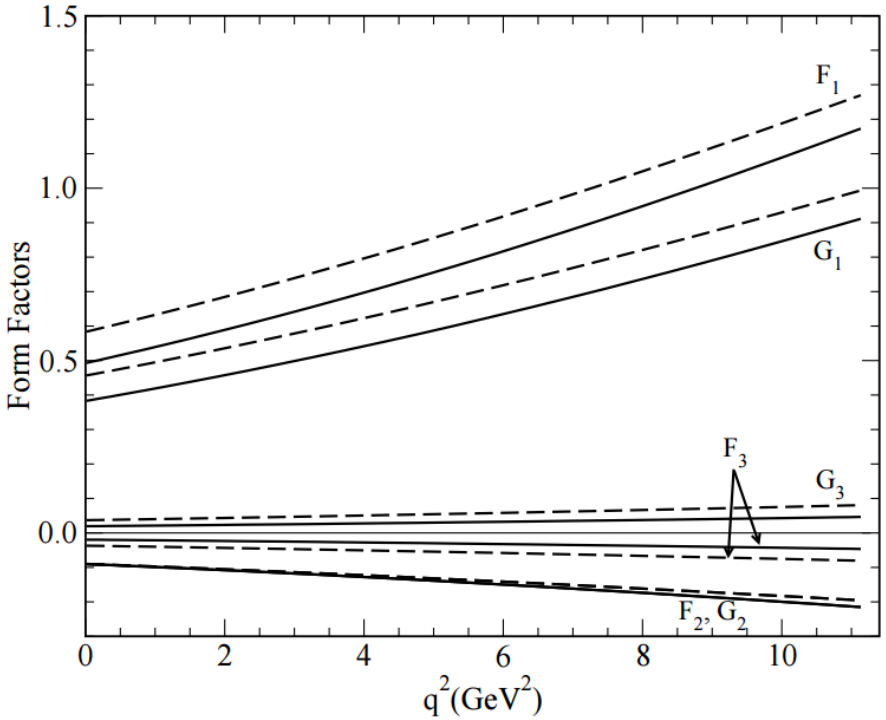
⇛ So in `EvtGen` the calculations of From Factors are done only in the harmonic oscillator basis.

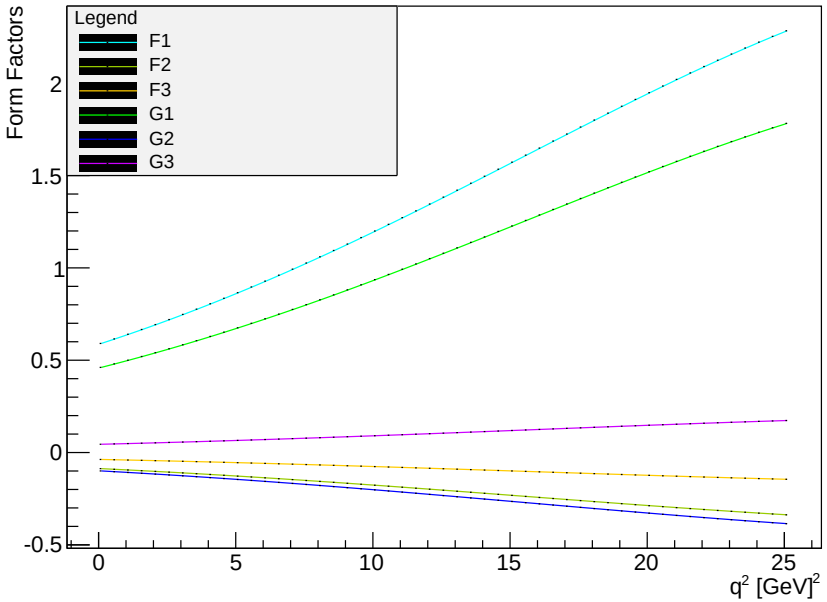
model	m_σ (GeV)	m_s (GeV)	m_c (GeV)	m_b (GeV)	b (GeV^2)	α_{Coul}	α_{hyp}	C_{qqq} (GeV)
HONR	0.40	0.65	1.89	5.28	0.14	0.45	0.81	-1.20
HOSR	0.38	0.59	1.83	5.17	0.17	0.09	0.26	-1.45
STNR	0.40	0.64	1.87	5.28	0.13	0.35	0.31	-1.22
STSR	0.34	0.57	1.78	5.22	0.15	0.19	0.11	-1.23

⇛ On top of this you also have the wave size:

J^P	model	Λ_b $(\alpha_\lambda,\ \alpha_\rho)$	Λ_c $(\alpha_\lambda,\ \alpha_\rho)$	Λ $(\alpha_\lambda,\ \alpha_\rho)$	N $(\alpha_\lambda,\ \alpha_\rho)$
$1/2^+$	HONR	(0.59, 0.61)	(0.55, 0.58)	(0.49, 0.53)	0.48
$1/2^+$	HOSR	(0.68, 0.68)	(0.60, 0.61)	(0.52, 0.57)	0.54
$1/2^+$	STNR	(0.44, 0.66)	(0.41, 0.69)	(0.35, 0.75)	-
$1/2^+$	STSR	(0.46, 0.64)	(0.43, 0.67)	(0.38, 0.72)	-
$1/2^-$	HONR	-	(0.47, 0.49)	(0.40, 0.47)	0.37
$1/2^-$	HOSR	-	(0.55, 0.59)	(0.48, 0.54)	0.46
$1/2^-$	STNR	-	(0.60, 0.50)	(0.55, 0.54)	-
$1/2^-$	STSR	-	(0.61, 0.49)	(0.58, 0.51)	-
$3/2^+$	HONR	-	-	-	0.35
$3/2^+$	HOSR	-	-	-	0.44
$5/2^+$	HONR	-	-	-	0.35
$5/2^+$	HOSR	-	-	-	0.46

Form factor results (example $\Lambda_c^{1/2+}$)





⇛ So I check each of the three Form factors with calculations from `EvtGen` and they are in perfect agreement.

⇛ Wrote all the bispinor algebra routines, gamma matrices, etc.

⇛ Didn't finish writing the matrix element calculus, once this is done we have a reweighing routine with all the form factors inside that is plug and play!

Summary

- Form factors implemented with all the algebraic structure of $V - A$ currents.
- Working on matrix element computations.
- Reweighing should follow.
- Once that is ready we will test with of the discriminating variables are less form factor independent so they can be used in the selection.

Backup