Semileptonic form factors for $B_s \to D_s \ell \nu$ and $B_s \to K \ell \nu$ decays

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INTRODUCTION

Motivation

- LHC experiments collect sufficiently many $B_s$ mesons
- Measurements at the LHC are complementary to those at $B$ factories
- Only spectator quark differs compared to $B \to \pi \ell \nu$
- Alternative determination of the CKM ratio $V_{us}/V_{ub}$
- Independent test of lepton flavour universality, $B_{K\ell}\nu$ a good proxy for $B_{D\ell}\nu$
- Numerically more precise prediction of form factors
- Preparation to determine $B_{B_s}$ for form factors

Numerical set-up

- Domain wall fermions (DWF) for up, down, and strange quarks
- Relativistic heavy quark (RHQ) action for bottom quarks [6,7]
- RBC-UKQCD 2+1 flavor DWF-basis gauge field ensembles [8-11]

Kinematic set-up: $B_{B_s}$ meson rest frame

Definition of form factors $f_+$ and $f_0$

$$(P^{BH}(q^2, \omega, M_{B_s})) = f^2(q^2, \omega, M_{B_s}) = f^2(q^2, \omega, M_{B_s})$$

for pseudoscalar final state $P = D_s, K, D, \pi$

$z$-parameterization

Bourjaily, Caprini, and Lellouch (BCL) [12]

$$f_+(q^2) = \frac{1}{1 - q^2/M_{B_s}^2} \sum_{k=0}^{N_{cusp}} a_k (-1)^k [q^2 - k^2]$$

$$f_0(q^2) = \frac{1}{q^2/M_{B_s}^2} \sum_{k=0}^{N_{cusp}} a_k (-1)^k [q^2 - k^2]$$

also going to consider Boyal, Grooten, and Lebed (BGL) [13] and Caprini, Lellouch, Neubert (CLN) [14] for $\tau \to e$ decays

REFERENCES


OUTLOOK

- Finalizing systematic uncertainties for $B_s \to D_s \ell \nu$ and $B_s \to K \ell \nu$
- Test BCL, BGL vs CLN $z$-parameterization
- Predict $B_{K\ell}\nu$ ratio to test lepton flavor universality
- Determine $B_{K\ell}\nu$ in combination with experimental measurements (e.g. LHC, CMS)
- Work in progress to calculate $B \to e\nu$ and $B \to D\ell\nu$ (talk by Ryan C. Hill)
- Addional $n F_{1}, n F_{2}$ points for other operators/vector final states already measured
- $B \to D\ell\nu$: $B_s \to D^*\ell\nu$
- $B \to K\ell\nu$: $B_s \to K^*\ell\nu$, $B_s \to D^*\ell\nu$...