Semi-Inclusive B Decays

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Introduction

What are Semi-Inclusive B Decays?

- Observation of a single hadron within the otherwise inclusive final state

$$B \to DX = B \to D\pi + B \to D\pi\pi + B \to D\ell\bar{\nu} + B \to D\Lambda_c p + \cdots$$

- Semi-inclusive semi-leptonic decays:

$$B \to DX\ell\bar{\nu} = B \to D\ell\bar{\nu} + B \to D\pi\ell\bar{\nu} + B \to Dp\bar{p}\bar{\nu} + \cdots$$

Why is this interesting?

- Obtain some insight into the anatomy of the Heavy Quark Expansion
- Understand fragmentation processes in Heavy Hadron Decays
- Inclusive rates in terms of a sum over exclusive rates

How to appoach semi-inclusive decays theoretically?

Start from the HQE for fully inclusive processes

$$\Gamma \propto \sum_X (2\pi)^4 \delta^4(P_H - P_X) |\langle X|\mathcal{H}_{eff}|H(v)\rangle|^2 = 2\,\mathrm{Im} \int d^4x\, \langle H(v)|T\{\mathcal{H}_{eff}(x)\mathcal{H}^\dagger_{eff}(0)\}|H(v)\rangle$$

Look at the OPE:

$$\int d^4x\, e^{-im_Q v\cdot x} T\{\widetilde{\mathcal{H}}_{eff}(x)\widetilde{\mathcal{H}}^\dagger_{eff}(0)\} = \sum_{n=0}^{\infty} \left(\frac{1}{2m_Q}\right)^n C_{n+3}(\mu)\mathcal{O}_{n+3}$$

- Wilson Coefficients C_k are computed in terms on quarks and gluons
- Duality between partons and hadrons
- Known from High Energies: Fragmentation of a quark into a hadron!
- Compute the C_k including a fragmentation function

Disclaimer!!!

- This is a model dependent approach!
- It will not reach the precision of the fully inclusive HQE
- Fragmentation functions are well investigated at high energies
- ... we have to see how far we can get at 5 GeV

A nice playground for a collaboration between experiment and theory