An effective hadronic field theory for B-meson decays at high recoil

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We construct an effective hadronic Lagrangian for heavy-meson decays into light energetic particles. In this theory, the dynamical degrees of freedom are given by quasi-static heavy meson fields coupled to soft and collinear pions, kaons and η mesons. We discuss two applications coming from NLO chiral logarithm calculations in this theory: $SU(3)$ flavour symmetry breaking; and chiral extrapolation of the pion mass for lattice, both for $B_i \to \pi_{ij}$ form factors at large recoil.

The theory combines the ideas of Heavy Hadron Chiral Perturbation Theory (HHChPT) and Soft-Collinear Effective Theory (SCET) to constrain the form of operators that describe the weak decay of a heavy meson to energetic goldstones. One can then connect the energy dependent Wilson coefficient that accompanies this operator to the form factor of the decay. Then, $SU(3)$ breaking and the pion mass dependence of these form factors can be calculated for energetic goldstones, in a very similar way it is done in HHChPT for low energies.

In my presentation, I introduce what decay constants and form factors are for B decays. Next, I focus on explaining all of the Effective Field Theories used to build up our project, based on their degrees of freedom, symmetries, and power counting. These EFTs are Heavy Quark Effective theory, (Heavy Hadron) Chiral Perturbation Theory and Soft-Collinear Effective Theory. I also comment on the limitations to low pion energies of Chiral Perturbation Theory.

To illustrate how we construct our matching from SCET II to our new theory, I explain the same procedure but for HHChPT. After this, I show our current candidate operator in the hadronic SCET theory that would represent B decays at large recoil, explaining the different parts that compose it.

Finally, I discuss the two applications mentioned above, with plots to illustrate the ideas better.