1 Introduction

These notes provide reading material on the Soft-Collinear Effective Theory (SCET). They are intended to cover the material studied in the second half of my effective field theory graduate course at MIT.

These latex notes will also appear as part of TASI lecture notes and a review article with Christian Bauer.

Familiarity will be assumed with various basic effective field theory (EFT) concepts, including power counting with operator dimensions, the use of field redefinitions, and top-down effective theories. Also the use of dimensional regularization for scale separation, the equivalences and differences with Wilsonian effective field theory, and the steps required to carry out matching computations for Wilson coefficients. A basic familiarity with heavy quark effective theory (HQET), the theory of static sources, is also assumed. In particular, familiarity with HQET as an example of a top-down EFT where we simultaneously study perturbative corrections and power corrections, and for understanding reparameterization invariance. These topics were covered in the first half of the EFT course.

A basic familiarity with QCD as a gauge theory will also be assumed. Given that SCET is a top-down EFT, we can derive it directly from expanding QCD and integrating out offshell degrees of freedom. This familiarity should include concepts like the fact that energetic quarks and gluons form jets, renormalization and renormalization group evolution for nonabelian gauge theory, and color algebra. Also some basic familiarity with the role of infrared divergences is assumed, namely how they cancel between virtual and real emission diagrams, and how they otherwise signal the presence of nonperturbative physics and the scale $\Lambda_{\rm QCD}$ as they do for parton distribution functions.

Finally it should be remarked that later parts of the notes are still a work in progress (particularly sections marked at the start as ROUGH which being around chapter 8). This file will be updated as more parts become available. Please let me know if you spot typos in any of chapters 1-7. The notes also do not yet contain a complete set of references. Some of the most frequent references I used for preparing various topics include:

1. Degrees of freedom, scales, spinors and propagators, power counting: [1, 2, 3]
2. Construction of $\mathcal{L}_{\rm SCET}$, currents, multipole expansion, label operators, zero-bin, infrared divergences: [2, 4, 5]
3. SCET$_{\rm I}$, Gauge symmetry, reparameterization invariance: [4, 6, 7]
4. Ultrasoft-Collinear factorization, Hard-Collinear factorization, matching & running for hard functions: [1, 2, 4, 6]
5. DIS, SCET power counting reduces to twist, renormalization with convolutions: [8, 9]
6. SCET$_{\rm II}$, Soft-Collinear interactions, use of auxillary Lagrangians, power counting formula, rapidity divergences: [6, 3, 10, 5, 11]
7. Power corrections, deriving SCET$_{\rm II}$ from SCET$_{\rm I}$: [12, 13, 10]

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