# 8.851 Homework 5

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**Problem 1) Renormalization of $c_F(\mu)$**

Draw the diagrams needed to compute the anomalous dimension of the coefficient $c_F(\mu)$ which appears in the magnetic moment Lagrangian $\mathcal{L}_F^{(1)}$. Discuss whether the kinetic energy Lagrangian $\mathcal{L}_K^{(1)}$ mixes with $\mathcal{L}_F^{(1)}$ under renormalization. Argue that the anomalous dimension vanish in the abelian case (and therefore is proportional to the adjoint Casmir $C_A$) without computing any integrals. (Hint: think about Coulomb gauge.)

**Problem 2) Heavy-to-Light Currents in HQET**

Consider the $\mathcal{O}(1/m_Q)$ heavy-to-light vector currents

$$
\begin{aligned}
O_1 &= \bar{q}\,\gamma^\mu i\overleftarrow{\slashed{D}} Q_v\,, & O_4 &= \bar{q}\,(-iv\cdot\overleftarrow{D})\gamma^\mu Q_v\,, \\
O_2 &= \bar{q}\,v^\mu i\slashed{D} Q_v\,, & O_5 &= \bar{q}\,(-iv\cdot\overleftarrow{D})v^\mu Q_v\,, \\
O_3 &= \bar{q}\,iD^\mu Q_v\,, & O_6 &= \bar{q}\,(-i\overleftarrow{D}^\mu)Q_v\,,
\end{aligned}
\tag{1}
$$

with coefficients $B_1$ to $B_6$. Using reparameterization invariance determine which of these coefficients are fixed by the coefficients $C_1$ and $C_2$ of the leading order vector heavy-to-light currents $\bar{q}\gamma^\mu Q_v$ and $\bar{q}v^\mu Q_v$.

**Problem 3) Non-perturbative form factor corrections**

In Chapter 4 of the book do problem 3 parts a), b), and c). Feel free to use results given in problems 6-9 in Chapter 2.