Exercise 1: Rare decay $b \to s\gamma$

The amplitude for the transition $b \to s\gamma$

\[ A(b \to s\gamma) = A_u + A_c + A_t \]

can be written as the sum of contributions from the three up-type quarks,

1. Rewrite $A(b \to s\gamma)$ explicitly in terms of CKM elements and loop functions.
2. Exploit the unitarity of the CKM matrix to eliminate $A_u$.
3. Discuss the size of the $t$ and $c$ contributions to the total amplitude.
4. Discuss the amplitude $A(c \to u\gamma)$. What is different?

Exercise 2: Rare decays $B^0_d \to K^*\mu^+\mu^-$ and $B^0_s \to \mu^+\mu^-$

The processes $B^0_d \to K^*\mu^+\mu^-$ and $B^0_s \to \mu^+\mu^-$ are mediated by the same Feynman diagrams. The decay branching ratios, however, are very different. Experimentally, one measures

\[ B(B^0_d \to K^*\mu^+\mu^-) \approx 10^{-6}, \quad B(B^0_s \to \mu^+\mu^-) \approx 10^{-9}. \]

1. Why is the decay $B^0_s \to \mu^+\mu^-$ suppressed compared to $B^0_d \to K^*\mu^+\mu^-$?
2. Write down the dimension-6 operators that contribute to $B^0_d \to K^*\mu^+\mu^-$ in the effective theory of weak interactions.