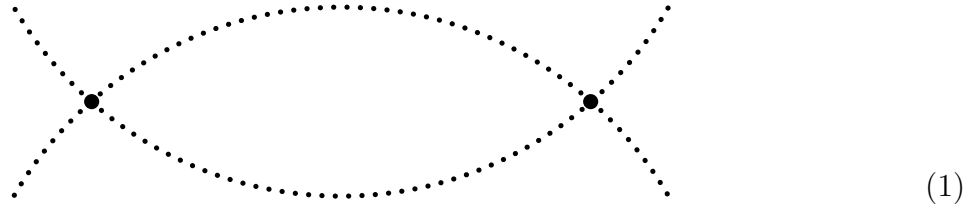


In class, we have evaluated the one-loop diagram



using the *hard-edge cutoff* as an ultraviolet regulator. Your task is to evaluate the same diagram using two other UV regulators: (1) Pauli-Villars, and (2) higher derivatives.

Show that all three regulators lead to the same amplitude $F(t; \lambda_{\text{bare}}, \Lambda)$ — modulo terms which become negligible for $\Lambda \rightarrow \infty$ — provided each regulator uses a slightly different cutoff scale Λ . The Λ s of all regulators are proportional to each other, thus

$$\Lambda_{\text{hard edge}}^2 = \Lambda_{\text{Pauli-Villars}}^2 \times c = \Lambda_{\text{higher derivative}}^2 \times c' \quad (2)$$

for some $O(1)$ numeric coefficients c and c' .