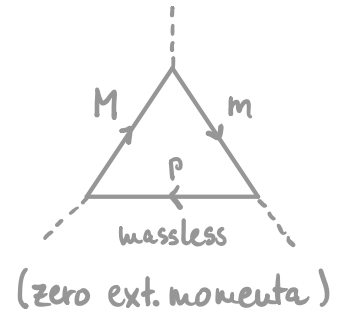## Exercise class 19 May 2022

Exercise 1:

Perform the region analysis for the integral:

$$I = \mu^{2\epsilon} \int \frac{d^D p}{(2\pi)^D} \frac{1}{p^2 (p^2 - M^2)(p^2 - m^2)} \quad ; \quad M^2 \gg m^2$$

M m

p

massless

(zero ext. momenta)

Useful integrals:

$$\int \frac{d^D \ell}{(2\pi)^D} \frac{1}{(\ell^2 - \Delta)^n} = (-1)^n \frac{i}{(4\pi)^{D/2}} \frac{\Gamma(n - D/2)}{\Gamma(n)} \Delta^{D/2 - n}$$

$$\int \frac{d^D p}{(2\pi)^D} \frac{1}{p^2 - M^2} \frac{1}{(p^2)^a} = -\frac{i}{(4\pi)^{D/2}} \Gamma\left(1 - \frac{D}{2}\right) (M^2)^{\frac{D}{2} - 1 - a}$$

Exercise 2 :

Evaluate the collinear contribution

$$I_c = i \, \pi^{-D/2} \, \mu^{2\epsilon} \int d^D k \, \frac{1}{(k^2 + i0) \left[(k+p_1)^2 + i0 \right] \left[2k \cdot p_{2+} + i0 \right]}$$

to the Sudakov form factor and give an EFT inter-pretation.

Feynman parameters for linear propagators:

$$\frac{1}{A^a B^b} = \frac{\Gamma(a+b)}{\Gamma(a)\,\Gamma(b)} \int_0^\infty d\lambda \, \frac{\lambda^{b-1}}{(A + \lambda B)^{a+b}}$$

↑

linear propagators

Exercise 3 :

Evaluate the integral

$$I = \int_{1}^{\infty} dx \, \frac{x^{-\epsilon}}{x + \mu x^3} \quad ; \quad 0 < \mu \ll 1 \quad (\epsilon > -2)$$

using the method of regions, dropping terms of $O(\mu^2)$.