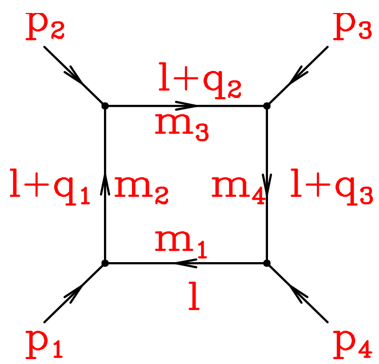
Box integrals

The definition of the box integrals are as follows

$$I_4^{\{D\}}(p_1^2,p_2^2,p_3^2,p_4^2;(p_1+p_2)^2,(p_2+p_3)^2;m_1^2,m_2^2,m_3^2,m_4^2) =$$
$$\frac{\mu^{4-D}}{i\pi^{\frac{D}{2}}r_\Gamma}\int d^Dl\frac{1}{(l^2-m_1^2+i\varepsilon)((l+q_1)^2-m_2^2+i\varepsilon)((l+q_2)^2-m_3^2+i\varepsilon)((l+q_3)^2-m_4^2+i\varepsilon)}$$

where $q_1 = p_1, q_2 = p_1 + p_2, q_3 = p_1 + p_2 + p_3$ and $q_0 = q_4 = 0$. The six-dimensional box integrals are discussed here.



After Feynman parametrization we have

$$I_4^{\{D=4-2\epsilon\}}(p_1^2,p_2^2,p_3^2,p_4^2;(p_1+p_2)^2,(p_2+p_3)^2;m_1^2,m_2^2,m_3^2,m_4^2) = \frac{\mu^{2\epsilon}\Gamma(2+\epsilon)}{r_\Gamma}\int_0^1 d^4a_i \, \frac{\delta(1-\sum_i a_i)}{\left[a_i a_j Y_{ij} - i\varepsilon\right]^{2+\epsilon}}$$

Y is the so-called modified Cayley matrix.

$$Y_{ij} = \frac{1}{2}\left[m_i^2 + m_j^2 - (q_{i-1} - q_{j-1})^2\right]$$

A necessary condition for a soft singularity is that for at least one value of i,

$$Y_{i\,i} = Y_{i\,i+1} = Y_{i\,i-1} = 0\ .$$

A necessary condition for a collinear singularity is that for at least one value of i,

$$Y_{i\,i} = Y_{i+1\,i+1} = Y_{i\,i+1} = 0\ .$$

If neither of these conditions is satisfied the integral is finite and can be evaluated by general techniques[1, 2, 3]. The general d-dimensional integrals are also known[4]. However the general form require considerable manipulation before they can be used in specific cases.

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