Bubble integrals

The definition of the bubble integral is as follows

$$I_2^{\{D\}}(q^2; m_1^2, m_2^2) = \frac{\mu^{4-D}}{i\pi^{\frac{D}{2}} r_\Gamma} \int d^D l \frac{1}{(l^2 - m_1^2 + i\varepsilon)((l+q)^2 - m_2^2 + i\varepsilon)}$$

μ is a scale introduced so that the integrals preserve their natural dimensions, despite excursions away from $D = 4$.

Using Feynman parameters the integral becomes

$$\begin{aligned} I_2^{\{D=4-2\epsilon\}}(q^2; m_1^2, m_2^2) &= \mu^{2\epsilon} \frac{\Gamma(\epsilon)}{r_\Gamma} \int_0^1 da\, [-a(1-a)q^2 + am_2^2 + (1-a)m_1^2 - i\varepsilon]^{-\epsilon} \\ &= \mu^{2\epsilon} \left[\frac{1}{\epsilon} - \int_0^1 da\, \ln\big(-a(1-a)q^2 + am_2^2 + (1-a)m_1^2 - i\varepsilon \big) \right] + \mathcal{O}(\epsilon) \end{aligned}$$

The full results for the general integral $I_2^{\{D=4-2\epsilon\}}(s; m_1^2, m_2^2)$ and some special cases are given.

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