11.2 DR and short distance physics.
Our usual regularisation methods are based on modifying the short-distance (=UV) behavior. Discuss what happens in DR for the typical integral

$$I(\omega) = \int \frac{\mathrm{d}^{2\omega}k}{(2\pi)^{2\omega}} \frac{1}{[k^2 + M^2 + \mathrm{i}\varepsilon]^\alpha} \tag{209}$$

where $2\omega = d = 4 - 2\varepsilon$. The parameter M contains the dependence on masses m_i and external momenta p. Perform the integral over the -2ε extra dimensions and rewrite $I(\omega)$ as

$$I(\omega) = c(\varepsilon) \int \frac{\mathrm{d}^4k}{(2\pi)^4} \frac{1}{[k^2 + M^2 + \mathrm{i}\varepsilon]^\alpha} R(\varepsilon)\,. \tag{210}$$

What is the behavior of the regulator $R(\varepsilon)$?

We split the integral into the usual 4-dimensional part and a piece containing the additional -2ε dimensions,

$$I(\omega) = \int \frac{\mathrm{d}^{-2\varepsilon}k}{(2\pi)^{-2\varepsilon}} \frac{\mathrm{d}^4k}{(2\pi)^4} \frac{1}{[k^2 + k_\varepsilon^2 + M^2 + \mathrm{i}\varepsilon]^\alpha}\,. \tag{211}$$

Adding the mass scale $\mu^{2\varepsilon}$ and performing the integral over -2ε extra dimensions, we obtain

$$I(\omega) = \frac{\Gamma(\alpha+\varepsilon)}{\Gamma(\alpha)} \int \frac{\mathrm{d}^4k}{(2\pi)^4} \frac{1}{[k^2 + M^2 + \mathrm{i}\varepsilon]^\alpha} \left(\frac{k^2+M^2}{4\pi\mu^2}\right)^{-\varepsilon}\,. \tag{212}$$

The prefactor goes to one for $\varepsilon \to 0$. The final factor

$$R(\varepsilon) \equiv \rho^{-\varepsilon} \equiv \left(\frac{k^2+M^2}{4\pi\mu^2}\right)^{-\varepsilon} \tag{213}$$

plays the role of a regulator, with

$$\rho^{-\varepsilon} = \mathrm{e}^{-\varepsilon \ln\rho} \to 1 \tag{214}$$

for $|\ln\rho| \ll 1/\varepsilon$. Thus physics is unchanged, if the loop momentum k *and* the external momenta and masses are of order μ. If however k or M are much larger than μ such that $\ln\rho \gg 1/\varepsilon$, then the factor $\rho^{-\varepsilon}$ will improve the convergence of the integral—thus short distance physics is modified as expected.
Note that i) physics is also changed in the opposite limit, i.e. when k *and* M are much smaller than μ. If particles are massive, then M^2 is bounded from below and no problem arises. Second, going to $2\omega = d = 4+2\varepsilon$, i.e. changing the sign of ε, we can use DR to regularize IR divergencies.