13. Problemset Relativistic Quantum Field Theory
January 31, 2018

C^μ / Self-Energy / Vertex

13.1 C^μ

Use the tensor reduction formalism to derive expressions for the invariants $C_1(p_1,p_2;m_0,m_1,m_2)$ and $C_2(p_1,p_2;m_0,m_1,m_2)$

$$C^\mu(p_1,p_2;m_0,m_1,m_2) = p_1^\mu C_1(p_1,p_2;m_0,m_1,m_2)+p_2^\mu C_2(p_1,p_2;m_0,m_1,m_2)$$
$$= \frac{(2\pi\mu)^{4-D}}{\mathrm{i}\pi^2}\int \mathrm{d}^D q\, \frac{q^\mu}{(q^2-m_0^2)\left((q+p_1)^2-m_1^2\right)\left((q+p_2)^2-m_2^2\right)} \quad (1)$$

in terms of the scalar integrals B_0 and C_0.

13.2 Transversality of the QED Vacuum Polarization

Show that

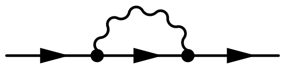
$$\Sigma_L(p^2) = \frac{\alpha}{\pi}\frac{\mathrm{tr}\,\mathbf{1}}{4}\Big(2B_{00}(p;m,m) + 2p^2(B_{11}(p;m,m) + B_1(p;m,m))$$
$$+ \frac{p^2}{2}B_0(p;m,m) - A_0(m)\Big) \quad (2)$$

vanishes by expressing the invariants B_{00}, B_{11} and B_0 through scalar integrals B_0 and A_0.

13.3 QED Electron Self Energy

Compute the electron's self energy

$$\mathrm{i}\Sigma(p) = \tag{3}$$

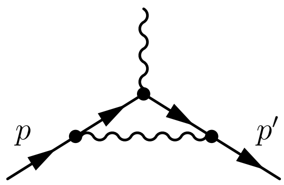


in QED using the tensor decomposition technique.

13.4 Vertex Correction

Compute the *divergent* part of the electron's vertex correction

$$\mathrm{i}\Lambda_\mu(p, p') = \tag{4}$$



in QED using the tensor decomposition technique.