Griffiths.

7.28. Apply Casimir's trick to compute

$$|\mathcal{M}|^2 = |\mathcal{M}_1|^2 + |\mathcal{M}_2|^2 + \mathcal{M}_1 \mathcal{M}_2^* + \mathcal{M}_2 \mathcal{M}_1^*$$

where $$\mathcal{M}_1 = \frac{g_e^2}{(p_1 - p_3)^2 - m^2c^2} [\bar{u}_4 \not{\epsilon}_2 (\not{p}_1 - \not{p}_3 + mc) \not{\epsilon}_3^* u_1],$$

$$\mathcal{M}_2 = \frac{g_e^2}{(p_1 + p_2)^2 - m^2c^2} [\bar{u}_4 \not{\epsilon}_3^* (\not{p}_1 + \not{p}_2 + mc) \not{\epsilon}_2 u_1].$$

$$|\mathcal{M}_1|^2 = (-1) [\bar{u}_4 \not{\epsilon}_2 (\not{p}_1 - \not{p}_3 + mc) \not{\epsilon}_3^* u_1] u_1^* \not{\epsilon}_3 (\not{p}_1 - \not{p}_3 + mc) \not{\epsilon}_2^* \gamma^0 u_4]$$

$$= (\cdots) [\bar{u}_a T_1 u_b] [\bar{u}_a T_1 u_b]^*$$

where $\bar{u}_a = \bar{u}_4$, $u_b = u_1$, $T_1 = \not{\epsilon}_2 (\not{p}_1 - \not{p}_3 + mc) \not{\epsilon}_3^*$.

By Casimir's trick, we have

$$\langle |\mathcal{M}_1|^2 \rangle = \mathrm{Tr}[T_1 (\not{p}_4 + m_4 c) \bar{T}_1 (\not{p}_1 + m_1 c)] (\cdots)$$

$$|\mathcal{M}_2|^2 = (\cdots) [\bar{u}_4 T_2 u_1] [\bar{u}_4 T_2 u_1]^*$$

$$\Rightarrow \langle |\mathcal{M}_2|^2 \rangle = \mathrm{Tr}[T_2 (\not{p}_4 + m_4 c) \bar{T}_2 (\not{p}_1 + m_1 c)] (\cdots)$$

$$M_1 M_2^* = (\cdots)\left[\bar{u}_4 \Gamma_1 u_1\right]\left[\bar{u}_4 \Gamma_2 u_2\right]^*$$

$$\Rightarrow \langle M_1 M_2^* \rangle = \mathrm{Tr}\left[\Gamma_1 (\not{p}_4 + m_4 c)\bar{\Gamma}_2 (\not{p}_1 + m_1 c)\right](\cdots).$$

$$M_2 M_2^* = (\cdots)\left[\bar{u}_4 \Gamma_2 u_1\right]\left[\bar{u}_4 \Gamma_1 u_1\right]^*$$

$$\Rightarrow \langle M_2^* M_2 \rangle = \mathrm{Tr}\left[\Gamma_2 (\not{p}_4 + m_4 c)\bar{\Gamma}_1 (\not{p}_1 + m_1 c)\right](\cdots).$$

Adding in the appropriate factors we have

$$\langle |M_1|^2 \rangle = \langle |M_1|^2 \rangle + \langle |M_2|^2 \rangle + \langle M_1 M_2^* \rangle + \langle M_1^* M_2 \rangle .$$

$$= \frac{g_e^4}{(p_1 - p_3^2 - m_e^2 c^2)^2} \mathrm{Tr}\left\{\Gamma_1 (\not{p}_4 + m_e c)\bar{\Gamma}_1 (\not{p}_1 + m_e c)\right\} \frac{1}{4}$$

$$+ \frac{g_e^4}{((p_1 + p_2)^2 - m_e^2 c^2)^2} \mathrm{Tr}\left\{\Gamma_2 (\not{p}_4 + m_e c)\bar{\Gamma}_2 (\not{p}_1 + m_e c)\right\} \frac{1}{4}$$

$$+ \frac{g_e^4}{((p_1 - p_3)^2 - m_e^2 c^2)((p_1 + p_2)^2 - m_e^2 c^2)} \mathrm{Tr}\left\{\Gamma_1 (\not{p}_4 + m_e c)\bar{\Gamma}_2 (\not{p}_1 + m_e c)\right\} \frac{1}{4}$$

$$+ \frac{g_e^4}{((p_1 - p_3)^2 - m_e^2 c^2)((p_1 + p_2)^2 - m_e^2 c^2)} \mathrm{Tr}\left\{\Gamma_2 (\not{p}_4 + m_e c)\bar{\Gamma}_1 (\not{p}_1 + m_e c)\right\} \frac{1}{4}.$$

where $\Gamma_1 = \xi_2 (\not{p}_1 - \not{p}_3 + m_e c)\xi_3^*$, $\bar{\Gamma}_2 = \xi_3^* (\not{p}_1 + \not{p}_2 + m c)\xi_2$