FY3403 Particle physics
Problemset 7 fall 2013

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Problem 14. Averaged scattering amplitude and cross section
Consider the spin-averaged amplitude for electron-muon scattering:

$$\langle |\mathcal{M}|^2 \rangle = \frac{g_e^4}{4(p_1 - p_3)^4} \mathrm{Tr}\{\gamma^\mu(\not{p}_1 + mc)\gamma^\nu(\not{p}_3 + mc)\} \times \mathrm{Tr}\{\gamma_\mu(\not{p}_2 + Mc)\gamma_\nu(\not{p}_4 + Mc)\} \quad (1)$$

where m is the electron mass, M is the muon mass, p_1 corresponds to the incoming electron, p_2 is the incoming muon, p_3 is the outgoing electron, and p_4 is the outgoing muon. Compute the traces in this expression and evaluate the resulting expression in the CM-frame under the assumption of high-energy scattering ($m, M \to 0$). Finally, obtain the CM differential cross section expressed with (among other things) the electron energy E and the scattering angle θ.

Problem 15. Loop diagram
Consider the vacuum polarization diagram (see *e.g.* Griffiths book chapter 7) where a virtual photon momentarily splits into an electron-positron pair. This is a fourth-order correction to lepton-lepton' scattering (*e.g.* electron-muon scattering). Derive in detail the scattering amplitude $\mathcal{M}$ for this process (it is sufficient to write down the amplitude in integral form: you do not have to evaluate the traces and perform the integration).