

## Exercises for "Phenomenology of Particle Physics I"

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sheet 9

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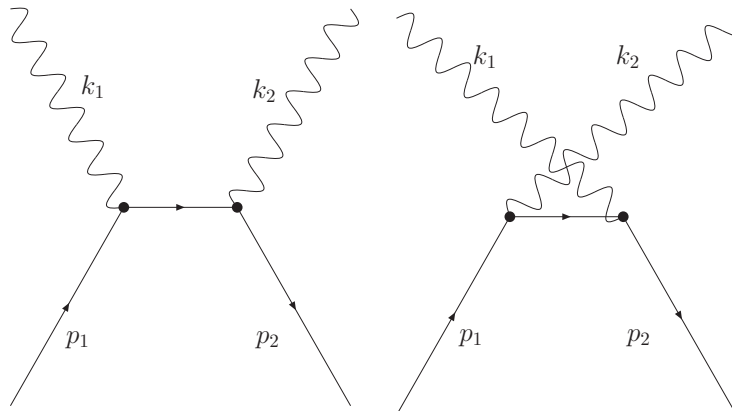
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### Exercise 25

The aim of this exercise is to evaluate the unpolarized differential cross section  $\frac{d\sigma}{dt}$  for Compton scattering. The following two graphs contribute to order  $e^2$ :



The amplitude  $\mathcal{M}$  consists of two terms, the second graph can be seen as the  $u$ -channel of the first graph. Use the crossing relations to get  $|\mathcal{M}_{u\text{-channel}}|^2$  from  $|\mathcal{M}_{s\text{-channel}}|^2$  and use  $|\mathcal{M}_{s\text{-channel}} + \mathcal{M}_{u\text{-channel}}|^2 = |\mathcal{M}_{s\text{-channel}}|^2 + |\mathcal{M}_{u\text{-channel}}|^2 + 2\Re(\mathcal{M}_{s\text{-channel}}\mathcal{M}_{u\text{-channel}}^*)$  to reduce the explicit calculation to two traces.

Average over spins/polarizations of incoming particles and sum over spins/polarizations of outgoing particles and use the completeness relations. We recall a few identities:

- $\text{Tr}(\gamma^\alpha\gamma^\beta) = 4g^{\alpha\beta}$
- $\text{Tr}(\text{odd number of } \gamma \text{ matrices}) = 0$
- $\text{Tr}(\gamma^\rho\gamma^\sigma\gamma^\zeta\gamma^\xi) = 4(g^{\rho\sigma}g^{\zeta\xi} + g^{\rho\xi}g^{\sigma\zeta} - g^{\rho\zeta}g^{\sigma\xi})$

- $\gamma^\mu \gamma_\mu = 4$
- $\gamma^\mu \gamma^\rho \gamma_\mu = -2\gamma^\rho$
- $\gamma^\mu \gamma^\rho \gamma^\sigma \gamma_\mu = 4g^{\rho\sigma}$
- $\gamma^\mu \gamma^\rho \gamma^\sigma \gamma^\delta \gamma_\mu = -2\gamma^\delta \gamma^\sigma \gamma^\rho$
- $\sum_\lambda \epsilon_\mu^{*\lambda}(p) \epsilon_\nu^\lambda(p) = -g_{\mu\nu}$  (for external photons)
- $\sum_s u^s(p) \bar{u}^s(p) = \not{p} + m$
- $\frac{d\sigma}{dt} = \frac{|\mathcal{M}|^2}{16\pi(s-m^2)}$