

QUANTUM FIELD THEORY 1

Problem sheet 3

1. Consider the scattering process

$$1 + 2 \rightarrow 3 + 4,$$

where particles 1,2,3,4 have different masses m_1, m_2, m_3 and m_4 . Calculate the energies of particles 1 and 3 and $\cos \theta$, where θ is the scattering angle between particles 1 and 3, in terms of the Mandelstam variables s and t and the masses:

- (a) In the centre-of-mass frame.
(b) In the rest frame of particle 2
2. For a theory of two real scalar particles ϕ and χ , whose Lagrangian density is given by

$$\mathcal{L} = \frac{1}{2}\partial_\mu\phi\partial^\mu\phi - \frac{1}{2}m^2\phi^2 + \frac{1}{2}\partial_\mu\chi\partial^\mu\chi - \frac{1}{2}M^2\chi^2 - \frac{g}{2}\chi\phi^2,$$

Calculate (to leading order in g) the differential cross-section $\frac{d\sigma}{dt}$ for the process

$$\phi + \chi \rightarrow \phi + \chi$$