QFT2 — Assignment 3: QED

1. **Møller Scattering**

Compute the differential cross section for Møller scattering $(e^- e^- \rightarrow e^- e^-)$ in the centre of mass frame. Express your answer in terms of the energy E of one of the particles, the particle mass m, and the centre of mass scattering angle θ.

2. J/ψ **decay constant**

(i) The J/ψ is a charm-anticharm vector meson whose discovery confirmed the reality of quarks to many physicists. Define the J/ψ decay constant, f_ψ, via the relation

$$\langle \psi(p,\lambda)|\bar{c}\gamma_\mu c|0\rangle = f_\psi m_\psi \epsilon_\mu^*(p,\lambda)$$

where p and λ are the J/ψ's four-momentum and polarisation respectively. Use this definition to compute the decay rate for $J/\psi \rightarrow e^+ e^-$. Write your answer in terms of α, the charge of the charm quark $(=Qe)$, the decay constant, and the J/ψ and electron's masses.

(ii) Use $Q = 2/3$, $m_\psi = 3.097$ GeV, and $\Gamma(\psi \rightarrow ee) = 5.39$ keV to obtain the decay constant.