Exercise sheet 7

1. Polarization vector of a massive spin-1 particle.
Derive the completeness relation for a massive spin-1 particle,

$$\sum_{r=1}^{3} \varepsilon_{\mu}^{(r)} \varepsilon_{\nu}^{(r)*} = -\eta_{\mu \nu} + k_{\mu} k_{\nu} / m^2,$$

as follows: Choose for simplicity the rest-frame construct then three mutually orthogonal polarization vectors $\varepsilon_{\mu}^{(r)}$ with the property $k^{\mu} \varepsilon_{\mu}^{(r)} = 0$ and $\varepsilon_{\mu}^{(r)} \varepsilon^{\mu(r)} = -1$. Then generalise the result for an arbitrary frame.

2. Z decays.
Calculate the decay width $\Gamma$ of the $Z$ boson into fermion pairs $f \bar{f}$ using as interaction vertex

$$-i \frac{g}{2 \cos \theta_W} \gamma_{\mu} (g_V - g_A \gamma^5)$$

where $g_V$ and $g_A$ are real coupling constants. You may set $m_f = 0$.

Solutions are discussed Thursday, 25.10.18