arrive at

$$
\begin{aligned}
E_{\text{Proca}} &= 2\,k^{0\,2} \sum_{\lambda=1,2,3} |\epsilon_\lambda \cdot \mathcal{A}|^2 \\
&= \int \frac{d^3k}{(2\pi)^3} \frac{e^2}{2} \sum_{\lambda=1,2,3} \left| \epsilon_\lambda \cdot \left( \frac{p'}{k \cdot p'} - \frac{p}{k \cdot p} \right) \right|^2 \qquad \text{(F.80)} \\
&= \int \frac{d^3k}{(2\pi)^3} \frac{e^2}{2} \left( \frac{2p \cdot p'}{(k \cdot p')(k \cdot p)} - \frac{m^2}{(k \cdot p')^2} - \frac{m^2}{(k \cdot p)^2} \right). \qquad \text{(F.81)}
\end{aligned}
$$

## F.2 Field Theory Calculation

### F.2.1 Bremsstrahlung Radiation

We wish to calculate the field theory analog of the previous classical calculations. Following Peskin pgs. 182-183 [251], consider the diagrams in Fig. F.2 contributing to bremsstrahlung radiation.

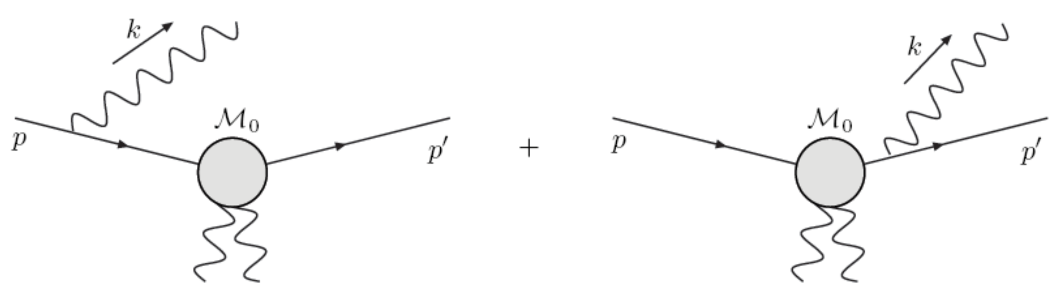


***Figure F.2:*** *Diagrams contributing to the probability of emitting a bremsstrahlung photon.*

Then, taking $\mathcal{M}_0$ to denote the part of the amplitude that comes from the