Physics 722 — Quantum Field Theory

homework 3 — due 23 March 2017

1. Bjorken and Drell, Ch. 19, problem 1, which is:

Prove the generalized Ward identity [the Ward-Takahashi identity] by forming the three-fold vacuum expectation value

$$\langle 0|T\left(\psi(x)\bar{\psi}(y)j_\mu(z)\right)|0\rangle$$

and using current conservation and the field equations.

(The current $j_\mu(z)$ is as usual $\bar{\psi}(z)\gamma_\mu\psi(z)$.)

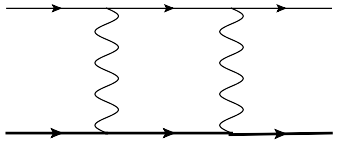
2. Suppose the QED Lagrangian contained an actual magnetic moment interaction, as

$$\mathcal{L} = \bar{\psi}\left(i\partial\!\!\!/ - m_0\right)\psi - e_0\bar{\psi}\gamma_\mu\psi\, A^\mu - \frac{\kappa_0}{2m_0}\bar{\psi}\sigma_{\mu\nu}\psi\, F^{\mu\nu}.$$

Give the superficial degree of divergence for Feynman diagrams in this theory in 4D in terms of the numbers of external legs and, if necessary, the number of vertices in the diagram. How many primitively divergent diagrams are there? For the sake of simplicity, you may let $e_0 = 0$.

Look up again, or recall, the meaning of renormalizable, superrenormalizable, and non-renormalizable, and state which of these QED with an intrinsic magnetic moment term is.

What is the degree of divergence of the box diagram,



where each vertex is the κ_0 vertex above?