QFT

Chapter 56: LSZ Reduction for Photons

Overview

- This is our third tedious time through LSZ reduction.
  - For the LSZ formula to hold, we have to renormalize the theory
  - This allows us to derive a new Wick's Theorem and a new free photon propagator, see problem 56.1.

- Now we write the path integral, and simplify it.
  - The path integral ends up in exactly the same form as it always is, namely: $$Z_0(J) = \exp\left[\frac{i}{2}\int d^4x d^4y J_\mu(x)\Delta^{\mu\nu}(x-y)J_\nu(y)\right]$$
  - But, the free-photon propagator can be Fourier-transformed and simplified. Additionally, it is convenient to move from Coulomb Gauge to Feynman gauge, allowing us to drop terms with factors of the wave function k. The result is: $$\tilde{\Delta}^{\mu\nu}(k) = \frac{g^{\mu\nu}}{k^2 - i\varepsilon}$$
  - More importantly, we now have a form for the free-field path integral

Next Steps

- In the next chapter, we evaluate the photon path integral directly, trying to gain some intuition.
- After that, we add an interaction term and spend the next eight chapters dealing with diagrams for photon-scalar and photon-fermion interactions.

- And after that (rest of the course)….
  - Gauge theory, particularly non-Abelian gauge theory
  - Assorted topics: ward identities, BRST symmetry, QCD, non-renormalizability, symmetry breaking, etc.
  - Construction of the standard model
  - Beyond the standard model (BSM) physics