QFT

Chapter 55: Electrodynamics in Coulomb Gauge

Gauge

- In classical E&M, recall that there is a gauge invariance: an infinite number of potentials can be chosen that yield the same fields
  - This is a real problem for us; the additional degrees of freedom cause there to be no canonically conjugate momentum, and therefore no dynamics.
  - We solve this by introducing a gauge freedom. In this case, we choose Coulomb gauge, which requires A, like B, to have a zero divergence.
  - We impose this by subtracting off the component of A that has a divergence.
  - Further, notice now that the divergence of A <u>is</u> zero, and we can literally use that in equations

Canonical Conjugation

- We notice now that A obeys the Klein-Gordon equation; in some sense, A is our spin-1 analog of φ.
  - As with φ, the next step is to decompose it into creation/annihilation operators and polarization vectors.
  - The Coulomb gauge condition requires the polarization to be perpendicular to the wave vector (direction of photon motion), so there are two polarization degrees of freedom. We take them to be right- and left-handed circular polarization.
- We then repeat the analysis of chapter 3 to determine the conjugation relations for our new creation/annihilation operators, and we derive our Hamiltonian in terms of these operators.
  - Srednicki outlines this process, and we do it for real in the problems