Physics 570 – Autumn 2017

Problem set #2 **Due Wednesday, 10/18/2017**

Reading for this problem set: Read through chapter 9.

Reading for next week's lectures: Chapters 9-11

1. I showed in class an indirect way to derive $\widetilde{dk} = \frac{d^3k}{(2\pi)^3 2\omega_k}$ to be a Lorentz invariant measure. Show by direct calculation using standard tools from multivariable calculus that
   (a) $\widetilde{dk}$ is invariant under rotations;
   (b) $\widetilde{dk}$ is invariant under a boost in the z direction (and hence from the above result, invariant under any boost, and hence invariant under any Lorentz transformation).

2. The time ordered product is defined as

$$T\left(\phi(x)\phi(y)\right) = \begin{cases} \phi(x)\phi(y) & x^0 > y^0 \\ \phi(y)\phi(x) & x^0 < y^0 \end{cases} .$$

   Using only the field equation and the equal time commutators (Srednicki eqs. 3.24, 3.28), show that for a free scalar field of mass m

$$\left(-\partial_\mu\partial^\mu + m^2\right)\langle 0|T\left(\phi(x)\phi(y)\right)|0\rangle = c\,\delta^4(x-y) ,$$

   and find the constant c.

3. Srednicki 8.5

4. Carefully compute the real and imaginary parts of $\frac{1}{k^2+m^2-i\epsilon}$ in the limit $\epsilon \to 0^+$.

5. Srednicki 8.8

6. Srednicki 9.1