Week 4 (due Feb. 5)

Reading: Srednicki, sections 41,42.

1. (a) Consider the theory of a single free Weyl fermion field with zero mass $m = 0$. Perform the canonical quantization of the theory: write down the commutation relations for fields and express the fields in terms of creation and annihilation operators. Show that there are two creation and two annihilation operators for every value of 3-momentum.

(b) Helicity is defined as the projection of the angular momentum on the direction of the particle 3-momentum. Show that the 1-particle states in the theory of a free massless Weyl fermion have helicity $\pm 1/2$.

(c) Show that the theory has a global $U(1)$ symmetry which does not exist in the massive theory. Find the corresponding conserved current.

(d) Express the charge of this $U(1)$ symmetry in terms of creation and annihilation operators and explain the physical meaning of this charge.