

Problem Set 4

Phys 7240
Due: Feb 24

1 Correlation Functions: Dirac Fermions

The action for the massless Dirac fermions reads

$$S = \int d^2\xi \left[\psi_R^\dagger \bar{\partial} \psi_R + \psi_L^\dagger \partial \psi_L \right]. \quad (1.1)$$

Here ξ_0 is imaginary time, ξ_1 is space, $\partial = \frac{\partial}{\partial z}$, and $z = \xi_0 + i\xi_1$.

Find the correlation functions $\langle \psi_R^\dagger(\xi) \psi_R(0) \rangle$, $\langle \psi_L^\dagger(\xi) \psi_L(0) \rangle$ and $\langle \psi_R^\dagger(\xi) \psi_L(0) \rangle$.

2 Correlation Functions: Bosons

Free bosons have the following action

$$S = \frac{1}{8\pi} \int d^2\xi (\partial_\mu \varphi)^2. \quad (2.1)$$

1. Find the correlation function $\langle \varphi(\xi) \varphi(0) \rangle$.
2. Find the correlation function $\langle e^{i\varphi(\xi)} e^{-i\varphi(0)} \rangle$. This can be calculated by using the definition

$$\langle e^{i\varphi(\xi)} e^{-i\varphi(0)} \rangle = \frac{1}{\int \mathcal{D}\varphi e^{-S}} \int \mathcal{D}\varphi e^{i\varphi(\xi) - i\varphi(0) - S}, \quad (2.2)$$

and noticing that this is simply a Gaussian functional integral.

3. Compare the correlation functions in this problem and in problem 1. The reason why some of the correlation functions coincide is due to bosonization, the equivalence between free bosons and Dirac fermions.