FYS4130 - Statistical Mechanics

University of Oslo

Obligatory assignment

Even Marius Nordhagen

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I CLUSTER SIZE

This problem aims an one dimensional lattice with N sites at a given temperature. There is a atom at each site that can either have energy $+\epsilon$ or $-\epsilon$, and a chain of sites with energy $+\epsilon$ is called a cluster.

I.1 Onebody probabilities

Since each atom can be in two possible energy states, the one-particle partition function has two terms

$$Z_1 = \sum_i e^{-\beta\epsilon_i} = e^{-\beta\epsilon} + e^{\beta\epsilon} \tag{1}$$

and the probability of an atom having energy $+\epsilon$ and $-\epsilon$ is

$$P_+ = \frac{e^{-\beta\epsilon}}{Z_1} = \frac{1}{1+e^{2\beta\epsilon}} \quad \text{and} \quad P_- = \frac{e^{\beta\epsilon}}{Z_1} = \frac{1}{1+e^{-2\beta\epsilon}} \tag{2}$$

respectively.

I.2 Probability of finding site in cluster

II ELECTRON GAS IN A MAGNETIC FIELD

Here we study a ...

II.1

III QUANTUM COULOMB GAS

Relativistic quantum gas with coulomb interaction

III.1

IV NON-INTERACTING FERMIONS

In this problem we study a non-interacting fermi gas with chemical potential μ. The particle states are given by the vector $\vec{k}$, which is d-dimensional where d is number of spatial dimensions, and the corresponding energy is $\epsilon(\vec{k})$.

IV.1 Joint probability

The joint probability of finding a particle in a state given by the occupation numbers $\{n_{\vec{k}}\}$ is given by the general probability statement in a grand canonical ensemble

$$P(\{n_k\}) = \frac{e^{-\beta n_k(\epsilon_k - \mu)}}{\Xi} \tag{3}$$