Topics in Many Body Theory

somer term 2020-21

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Lectured together with dr hab. Paweł Jakubczyk

Rules

Lectures and tutorials will be carried out online via Zoom.

Permanent link for my lectures and tutorials on Tuesdays:

https://zoom.us/j/93132290134?pwd=
SFJsVGhyWWdjMUkrVUpLT3V3ZFNMdz09
Meeting ID: 931 3229 0134
Passcode: 8U2j04

1 Week I, 01-07/03/2020

1.1 Tutorial

1. *Generating function* - For an arbitrary measure (probability distribution) in real n-dimensional space introduce the generating function for correlation functions. Check it properties.

2. *Gaussian integrals in n-dimensions* - Find the value of a gaussian integral of real variables in n-dimensional space.

3. *General gaussian integral* - Find the value of a gaussian integral with a linear term of real variables in n-dimensional space.

4. *Gaussian averages and Wick's theorem* - For a gaussian measure find a general expression of an average of a polynomial function. Formulate the Wick's theorem.

5. *Perturbed gaussian measure* - Using a perturbation expansion find a general expression for a perturbed gaussian measure. Apply in case of quartic polynomial function.

1.2 Homework problems

1. Show that

$$\langle x_{k_1} x_{k_2} ... x_{k_l} \rangle = \left. \frac{\partial}{\partial b_{k_1}} \frac{\partial}{\partial b_{k_2}} ... \frac{\partial}{\partial b_{k_n}} Z(\vec{b}) \right|_{\vec{b}=0}.$$

2. Show that

$$Z(A, \vec{b}) = e^{\Delta(\vec{b})} \int d^n y e^{-\mathbf{A}(\vec{y})},$$

where $\boldsymbol{\Delta}(\vec{b}) = \frac{1}{2} \sum_{ij=1}^{n} b_i \Delta_{ij} b_j$.

3. Compute $Z(\lambda)/Z(0)$ for $V(\vec{x}) = \frac{1}{4!} \sum_{i=1}^{n} x_i^4$ up to the second order in λ.

2   Literature

- W Greiner, B. Müller *Quantum mechanics - symmetries.*

- More to be added in the course.