

Exercise #05

due date: oral exam.

You can **alternatively** choose:

- exercises a) **and** b)
- point c) **or** d)

a) Prove the isomorphism between the Ising model in the Canonical Ensemble and the Lattice Gas model in the Grand-Canonical ensemble i.e. prove that $H_{\text{LG}} - \mu \langle N \rangle$ maps onto H_{Ising} up to some additive constants.

- Discuss the mean-field phase transition found in the Ising model in the context of the lattice-gas.

b) After reading chapter II of [R.J. Baxter - Exactly solved models in statistical mechanics-Academic Press (1982)].

- Solve the Ising one-dimensional model with the transfer matrix method and prove that there is no phase transition at non zero temperature.
- Discuss the zero temperature limit.

c) Following the instruction here below

<http://www.aquila.infn.it/ciuchi/didattica/DOTT/OpenSystems/index.html>

try to compile and run the program Oscillators (a fortran compiler is needed).

Once compiled successfully try exercises #1 #2 #3.

d) Derive the Landau theory for the superconducting transition after watching the following recorded lecture:

- Lecture 1

You can also follow a set of notes:

- The BCS model
- A resume of the solution of BCS model by mean-field approach.
- Technical details of Bogoliubov transformation
- Detailed solution of BCS model by mean-field approach.

For reading you can see the book of Linda E. Reichl "A Modern Course in Statistical Physics" chapt. 4 and chapt. 6.11

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