

Material for Week 9

Physics 4488/6562: Statistical Mechanics

<https://sethna.lassp.cornell.edu/Teaching/562/>

Exercises due Mon. Mar 27

Last correction at December 22, 2022, 9:09 pm

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For next Monday's pre-class question 9.2, do parts (a) and (b) only.

Monday

In-class question: [8.19](#) *2D Ising cluster expansions*

Wednesday

Read: Chapter 9, Sec. 9.1 (Broken symmetry) and 9.2 (Order parameter)

Pre-class question: [9.9](#) *Ising order parameter*

In-class question: [9.10](#) *Nematic order parameter*

Friday

Read: Chapter 9, Sec. 9.3 (Examine the elementary excitations)

Pre-class question: [9.15](#) *Superfluid second sound*

In-class question: [9.6](#) *Symmetries and wave equations*

Monday

Read: Chapter 9, Sec. 9.4 (Classify the topological defects)

Pre-class question: [9.2](#) *XY defects*

Exercises for everyone

[8.6](#) *Metropolis*. (Mathematics, Computation) The most common Monte-Carlo method

[8.8](#) *Wolff*. (Mathematics, Computation) Cluster flips satisfying detailed balance!

Select one (4488) or two (6562)

[8.21](#) *Fruit flies and Markov*. (Biology) Gordon Berman (Cornell PhD) used machine learning to study fly behavior, inspiring this exercise.

[9.5](#) *Landau theory for the Ising model*. (Condensed matter) Commonly used to study phase diagrams, defects, and boundary conditions. Ignores fluctuations.

[9.12](#) *Rigidity of crystals*. (Order parameters) Crystals flow under stress too. How are they different from liquids?

[9.14](#) *Sound and Goldstone's theorem*. (Condensed matter) Why long-wavelength fluctuations have low frequencies

[9.20](#) *Number and phase in superfluids*. (Quantum) An example of a powerful method for deriving equations of motion from commutation relations and Poisson brackets.

[8.23](#) *Kinetic proofreading in cells*. (Biology) How cells violate detailed balance to replicate DNA without errors.

[8.22](#) *Metastability and Markov*. Arrhenius barrier crossing as a Markov process. Prelude to Exercise 12.22. Hints at <https://sethna.lassp.cornell.edu/StatMech/EOPCHintsAndMaterials.html>