

## Material for Week 9

Physics 4488/6562: Statistical Mechanics

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

Exercises due Mon. Mar 25

Last correction at November 29, 2023, 9:47 pm

©2023, James Sethna, all rights reserved

The exercises with numbers N1.xxx are to be found in <https://sethna.lassp.cornell.edu/StatMech/SethnaExercises.pdf>

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 zero – one (4488) or one – 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.

N4.50 *Localization*. (Quantum, Condensed matter) Doped insulators and the metal-insulator transition.

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>