

## Material for Week 12

Physics 4488/6562: Statistical Mechanics

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

Exercises due Mon. Apr 21

Last correction at January 16, 2025, 6:36 pm

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This Wednesday and next Monday we shall be making use of your tablets and laptops to do simulations. Bring them!

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

### Monday

In-class question: [11.1](#) *Maxwell and van der Waals*

### Wednesday

Read: Chapter 11, Sec. 11.3 (Nucleation: critical droplet theory), and 11.4.1 (Coarsening)

Pre-class question: [11.12](#) *Nucleation in 2D*

In-class question: [11.6](#) *Coarsening in the Ising model*

### Friday

Read: Chapter 11, Sec. 11.4 (Morphology of abrupt transitions)

Pre-class question: [11.8](#) *Minimizing sequences and microstructure*

In-class question: [11.7](#) *Origami microstructure*

### Monday

Read: Chapter 12, Introduction

Pre-class question: [12.17](#) *The Gutenberg–Richter law*

## Assigned exercise for everyone

- 11.13 *Linear stability of a growing interface.* (Surface science) Growing surface steps can make dendrites.

## Special topic exercises (6562 do one; 4488 do 7 during 14 weeks)

- 11.5 *Nucleation of dislocation pairs.* (Engineering) When bent, a perfect crystalline wire will flow (slowly!) by creating dislocations. Is it a liquid? We analyze dislocation pairs nucleation under stress.
- N1.14 *Spinodals vs. Nucleation.* When will the barrier to form a raindrop vanish? Deep in the coexistence region, beyond the ‘spinodal’ line, water vapor will spontaneously condense without a nucleation barrier. (At least in theory. In the real world, it is thought that there is no sharp transition.)
- N1.6 *Beer foam and coarsening.* The theory of how beer bubbles grow with time! Von Neumann’s theory of 2D bubble coarsening.
- 11.16 *Mosh pits.* (Active matter) Heavy metal concert audiences naturally coarsen into moshers and drinkers.
- N1.8 *Where is the antimatter?* (Astrophysics) Bubble coarsening as a (failed) explanation for matter–antimatter asymmetry in the Universe.
- 11.14 *Nucleation of cracks.* (Engineering, Condensed matter) Bridges are metastable.
- 11.15 *Elastic theory does not converge.* (Engineering, Condensed matter) Like QED and Stirling’s formula, Hooke’s law for springs has zero radius of convergence.