

Material for Week 11

Physics 4488/6562: Statistical Mechanics

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

Exercises due Mon. Apr 15

Last correction at November 29, 2023, 9:48 pm

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Calculus of variations is needed for Wednesday's pre-class question, analogous to the derivation of the Euler-Lagrange equations in mechanics. The variational derivative is the first term in a 'function-space' Taylor series of $\mathcal{F}[\rho + \delta] - \mathcal{F}[\rho]$ with respect to $\delta(x)$.

Monday

In-class question: [10.13](#) *Onsager regression hypothesis*

Wednesday

Read: Chapter 10, Sec. 10.5 (Susceptibility and linear response) and 10.6 (Dissipation and the imaginary part)

Pre-class question: [10.14](#) *Liquid dynamics*

In-class question: [10.15](#) *Harmonic susceptibility, dissipation*

Friday

Read: Chapter 10, Secs. 10.7 (Static susceptibility), 10.8 (The fluctuation-dissipation theorem), and 10.9 (Causality and Kramers-Krönig)

Pre-class question: [10.16](#) *Harmonic fluctuation-dissipation*

Pre-class question: [10.18](#) *Harmonic Kramers-Kronig*

In-class question: [10.17](#) *Susceptibilities and correlations*

Monday

Read: Chapter 11, Sec. 11.1 (Stable and metastable phases) and 11.2 (Maxwell construction)

Pre-class question: [11.11](#) *Unstable to what?*

Exercises for everyone

[10.9](#) *Quasiparticle poles and Goldstone's theorem.* (Condensed matter) Poles in the susceptibility describe quasiparticles and their lifetimes.

Select zero – one (4488) or one – two (6562)

[10.1](#) *Cosmic microwave background radiation.* (Astrophysics) Fluctuation correlations in the echo of the Big Bang have peaks that tell us about dark matter and dark energy. One feature comes from 'acoustic' oscillations discussed here.

[10.4](#) *Spin.* (Condensed matter) Linear response for a spin in a thermal environment

[10.5](#) *Telegraph noise in nanojunctions.* (Condensed matter) Currents through nanojunctions can detect single atoms hopping, whose correlations we study.

[10.8](#) *Magnet dynamics.* (Condensed matter) Linear response for a continuum system.

[10.19](#) *Critical point response.* Linear response near a critical point (see Exercise 12.27)

[N1.15](#) *Cell signaling and mutual information.* (Biology, Statistics) Cells maximize *mutual information* by evolving signal pathways from membrane receptors sensing food to flagella moving them forward.