Material for Week 3

Physics 4488/6562: Statistical Mechanics

http://www.physics.cornell.edu/sethna/teaching/562/

Exercises due Mon. Feb 10

Last correction at March 12, 2020, 4:48 pm

All exercises are from Version 2.0 of the text: http://pages.physics.cornell.edu/~sethna/StatMech/v2EntropyOrderParametersComplexity.pdf

Monday

In-class question: 3.1 *Temperature and energy*

In-class question: 3.2 *Large and very large numbers*

In-class question: 3.10 *Triple product relation*

In-class question: 3.7 *Gas mixture*

Wednesday

Read: Chapter 3, Sec. 3.3 (Temperature) and 3.4 (Pressure & Chemical Potential; 3.4.1 is optional), Sec. 3.5 (Entropy & fussy stuff).

Pre-class question: 3.16 *Taste, smell, and* μ

In-class question: 3.5 *Hard sphere gas*

Friday

Read: Chapter 4, Sec. 4.1 (Liouville's theorem), Sec. 4.2 (Ergodicity)

Pre-class question: 4.6 *Perverse initial conditions*

In-class question: 4.2 *Liouville vs. the damped pendulum*

In-class question: 3.11 *Maxwell relations*

In-class question: 3.19 *Random energy model*

Monday

Read: Chapter 5, Sec. 5.1 (Engines & Heat Death)

Pre-class question: 4.5 *No Hamiltonian attractors*

Exercises

Everyone (4488 and 6562)

5.8 *The Arnol'd cat map.*

4.8 *Jarzynski.* Liouville's theorem applies also to time-dependent Hamiltonians. Jarzynski, and later Crooks, used this to calculate the exact entropy change for a non-equilibrium process. Here we use an ideal gas, compressed non-adiabatically, to illustrate how this exact result is used in practice.

Graduate (6562 only)

4.3 *Invariant measures.* Dissipative dynamical systems have an 'invariant measure' that generalizes the phase-space averages justified by Liouville's theorem. Here we apply this to a chaotic, one-dimensional map exhibiting the period-doubling route to chaos. Hints are available in Python, Mathematica, and Matlab at http://pages.physics.cornell.edu/~sethna/StatMech/ComputerExercises.html.

4.7 *Crooks.* Here we derive the remarkable Crooks relation using Liouville's theorem