Material for Week 3

Physics 4488/6562: Statistical Mechanics

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

Exercises due Mon. Mar 01

Last correction at January 7, 2021, 1:26 pm

All exercises are from the second edition of the text: http://pages.physics.cornell.edu/~sethna/StatMech/EntropyOrderParametersComplexity20.pdf

Monday
In-class question: 3.5 *Hard sphere gas*
Wednesday
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*
Friday
Read: Chapter 5, Sec. 5.1 (Engines & Heat Death)
Pre-class question: 4.5 *No Hamiltonian attractors*
In-class question: 5.1 *Life and the heat death of the Universe*
Monday
Read: Chapter 5, Sec. 5.2.1 (Entropy of mixing)
Pre-class question: 3.18 *Ideal gas glass*

Exercises for 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.

Exercises for Graduate Course (6562 only)

3.14 *Pendulum energy shell.*

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/EOPCHintsAndMaterials.html or http://www.lassp.cornell.edu/sethna/StatMech/EOPCHintsAndMaterials.html

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