

Exercises in Statistical Mechanics

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This exercises pool is intended for a graduate course in “statistical mechanics”. Some of the problems are original, while other were assembled from various undocumented sources. In particular some problems originate from exams that were written by B. Horovitz (BGU), S. Fishman (Technion), and D. Cohen (BGU).

===== [Exercise 7020]

FDT for harmonic oscillator

A particle of mass m is described by its position x and velocity v . It is bounded by a harmonic potential of frequency Ω , and experiences a damping with a coefficient η . Additionally It is subject to an external force $f(t)$. The system is at temperature T .

- (a) Write the generalized susceptibility that describes the response of x to the driving by $f(t)$.
- (b) Using the FD relation deduce what are the power spectra of x and of v .
- (c) Write an integral expression for the autocorrelation function $\langle v(t)v(0) \rangle$. Find explicit results in various limits, e.g. for damped particle ($\Omega \rightarrow 0$).
- (d) Find $\langle x^2 \rangle$ and $\langle v^2 \rangle$ for $\eta \rightarrow 0$, both in the quantum and in the classical case. Verify consistency with the canonical results.