

3. Übungsblatt zur Statistische Physik I

Liouville's Equation

Abgabe: Mittwoch, 13th May, bis 16:00 Uhr, Raum E-W 705

Exercise 9 (3 points): *Continuity equation*

By considering the total rate-of-change of the probability that a system finds itself located within small volume ΔV in phase space, show that the conservation of probability implies the continuity equation

$$\frac{\partial \rho}{\partial t} + \nabla \cdot \mathbf{j} = 0,$$

with

$$\mathbf{j} = \rho \begin{pmatrix} \dot{\mathbf{q}} \\ \dot{\mathbf{p}} \end{pmatrix},$$

the probability current density.

Exercise 10 (3 points): *Probability distribution function of an observable*

Show that the time evolution of the ensemble average $\langle A \rangle \equiv \int d\Gamma \rho(\mathbf{q}, \mathbf{p}, t) A(\mathbf{q}, \mathbf{p})$ is given by

$$\frac{d}{dt} \langle A \rangle = \langle \{A, \mathcal{H}\} \rangle,$$

with the Poisson bracket $\{\cdot, \cdot\}$.

Exercise 11 (4 points): *One-dimensional gas*

A thermalised gas particle is suddenly confined to a one-dimensional trap with potential $V(q) = \text{const.}$ The corresponding mixed state is described by an initial density function

$$\rho(q, p, t = 0) = \delta(q) f(p); \quad \text{with} \quad f(p) = \frac{1}{\sqrt{2\pi m k_B T}} \exp(-p^2/2m k_B T).$$

Starting from Liouville's equation, derive $\rho(q, p, t)$ and sketch it in the (q, p) plane. Derive expressions for the averages $\langle p^2 \rangle$ and $\langle q^2 \rangle$.

Bitte Rückseite beachten! →

- **Internetseite der Veranstaltung:** http://www.itp.tu-berlin.de/menu/lehre/lv/ss09/wpfv/statphys_i/
- **Vorlesung:** Montags & Donnerstags, 14:15 bis 15:45, E-W 202
- **Literatur:**
 - F. Schwabl, Statistische Mechanik
 - M. Kardar, Statistical Physics of Particles & Statistical Physics of Fields
 - M. Plischke and B. Bergersen, Equilibrium Statistical Physics
 - H. B. Callen, Thermodynamics and an Introduction to Thermostatistics
- **Übung:** Donnerstags, 10:15 bis 11:45, E-W 733
- **Scheinkriterien:** 50% der Punkte aus den Übungszetteln (Zweierabgabe), aktive Teilnahme an den Tutorien
- **Sprechstunden:**
 - Prof. Dr. H. Stark: Fr. 11:30 - 12:30, E-W 709
 - Dr. C. Emary: Di, 16:00 - 17:00 Uhr, E-W 705