May 1, 2009

Technische Universität Berlin
Institut für Theoretische Physik
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Dr. Clive Emary http://www.itp.tu-berlin.de/menue/lehre/lv/ss09/wpfv/statphys_i/

2. Übungsblatt zur Statistiche Physik I

Wahrscheinlichkeit

Abgabe: Mittwoch, 6th May, bis 16:00 Uhr, Raum E-W 705

Exercise 5 (2 points): *Probability distribution function of an observable*
If random variable X is distributed according to the distribution function $P(X = x) = P(x)$, show that the observable $F = f(X)$ is distributed according to the distribution function

$$P(F = f) = P(f) = \langle \delta(f(x) - f) \rangle.$$

Exercise 6 (2 points): *Central moments of the Gaussian distribution*
Show that, for the Gaussian distribution

$$P(x) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left\{ -\frac{(x - x_0)^2}{2\sigma^2} \right\},$$

the central moments are given by

$$\langle (\Delta x)^n \rangle \equiv \langle (x - x_0)^n \rangle = \sigma^n (n-1)!!.$$

Use this result to find the first four moments and first four cumulants.

Exercise 7 (3 points): *Characteristic function*
Calculate the characteristic function $G(k) \equiv \langle e^{-ikx} \rangle$ for the following probability distribution functions:

- Homogeneous distribution,

$$P_a(x) = \begin{cases} 1/2a, & -a < x < a \\ 0, & \text{otherwise} \end{cases};$$

- Exponential distribution,

$$P_\lambda(x) = \begin{cases} \lambda e^{-\lambda x}, & x \geq 0 \\ 0, & \text{otherwise} \end{cases};$$

- Gaussian distribution ($P(x)$ as in Ex. 6)

Exercise 8 (3 points): *The Poissonian limit of the Binomial distribution*
The Binomial distribution for n events to occur from N trials with single-event probability p is

$$P_{p,N}(n) = \binom{N}{n} p^n (1-p)^{N-n}.$$

Show that, for fixed mean $\lambda = pN$, this distribution reproduces the Poisson distribution in the limit that the number of trials N becomes large.

Bitte Rückseite beachten!⟶

- **Internetseite der Veranstaltung:** http://www.itp.tu-berlin.de/menue/lehre/lv/ss09/wpfv/statphys_i/
- **Vorlesung:** Montags & Donnerstags, 14:15 bis 15:45, E-W 202
- **Literatur:**
  - 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