5. Präsenzübung, **Statistische Physik**

zu bearbeiten am Donnerstag, 10.11.2011

Aufgabe P13 *Filling orbitals*

The function

$$f(\epsilon) = \frac{1}{1 + e^{(\epsilon-\mu)/\tau}}$$

is the Fermi-Dirac function. It represents the probability that the energy level ϵ be occupied by a particle in an ideal gas of fermions, given the temperature τ and chemical potential μ.

a. Express the exact form of $f(\epsilon)$ in the limit $\tau \to 0$, and prove that your answer is correct.

b. Suppose that for one particle there are

$$G(\epsilon) = \epsilon \mathcal{D}$$

states with energy strictly below ϵ, where $\mathcal{D}$ is a constant. If there are N particles, and the temperature is zero, express the chemical potential μ as a function of N.

Aufgabe P14 *Integration of a 1-form*

Assuming that the number of particles N is constant, we want to find the entropy $\sigma(\tau, V)$ of a classical ideal gas as a function of the temperature τ and volume V (up to a constant term), using the fact that

$$d\sigma(U, V) = \frac{1}{\tau} dU + \frac{p}{\tau} dV$$

and the equation of state $pV = N\tau$ as well as the expression $U = \frac{3}{2} N\tau$ for the energy. In order to do so, first express the form $d\sigma$ in coordinates (τ, V), and then integrate it along a path. Then use your answer $\sigma(\tau, V)$ to verify that $d\sigma$ is indeed a closed form as its symbol suggests.