# Variational Nonequilibrium Statistical Mechanics

**Wintersemester 2018/19**
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## Blatt 12 - Hausaufgabe

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### Aufgabe 1: Lane formation

Consider an equimolar ($x_1 = x_2$, with $x_i$ the composition of species $i$) binary mixture of spherical colloidal particles. The only difference between both species is the buoyant mass, which is $m$ for species 1 and $-m$ for species 2. When the mixture is subject to a sufficiently strong homogeneous gravitational field $\mathbf{f}_{\text{ext}} = g\mathbf{e_y}$ the particles demix and form two lanes, each one rich in one species. The system reaches a steady state in which the density profiles are well described by:

$$\begin{aligned} \rho_1(x) &= \rho_b(1 + \tanh(x)), \\ \rho_2(x) &= \rho_b(1 + \tanh(-x)). \end{aligned} \tag{1}$$

a) Sketch a microstate of the system indicating all forces acting on each species.

b) Find the value of the x-component of the superadiabatic forces in steady state.

### Aufgabe 2: Viscous and structural forces

A two-dimensional system of isotropic colloidal particles is in steady state with velocity profile

$$\mathbf{v}(x, y) = \begin{pmatrix} v_1 \sin(2\pi y/L) \\ v_2 \end{pmatrix}, \tag{2}$$

and constant density profile. Here $v_1$ and $v_2$ are positive constants and $L \gg \sigma$, with $\sigma$ the particle length. Find an approximation for the external field required to sustain the flow. Sketch and interpret the results.