Stationary states of large systems: the microscopic, mesoscopic and macroscopic theories.

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There are two parts, the first one is devoted to thermal equilibrium, the second one to non equilibrium stationary states.

In the first part I will focus on phase transitions. I will consider dissipative systems where inertial effects can be neglected. The temperature is fixed at a value for which there is a phase transition, I will also suppose that the order parameter is only the mass density. I will then describe the phase transition for such systems in the frame of the macroscopic, mesoscopic and microscopic theories discussing their inter-relations.

In the second part I will discuss the stationary flow of mass in a one dimensional system where the densities at the boundaries are fixed at mutually different values. The macroscopic theory is the Fick's law (the analogue of the Fourier law for heat flux). At the microscopic level I will consider a lattice gas with stochastic updatings (the symmetric simple exclusion process, SSEP) and birth-death events at the boundaries which simulate density reservoirs.

I will also consider models where the reservoirs are described by infinite systems at equilibrium. Besides SSEP I will mention how the problem appears in the context of Hamiltonian systems and the Boltzmann equation. I will finally consider the case where at the boundaries the current rather than the density is fixed and how this leads to free boundary problems.