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Phase Transitions in Condensed Matter Systems

The transition between different phases of matter (e.g., from ice, to (liquid) water, to vapor) is probably one of the most fascinating concepts in physics; and it is also one of the most complex ones.

Why does one actually observe a succession of phases in many systems as for e.g. temperature rises? The basic reason is the competition between lowering energy and increasing disorder (and whereby entropy) in the free energy, which has to be minimized by a thermal equilibrium state.

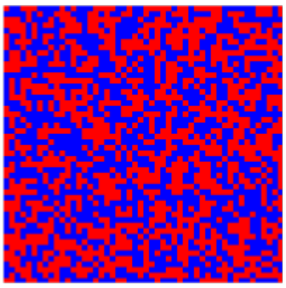
Phase transitions are thus intimately related to a change in the order of the system (leading to the concept of an *order parameter*) and oftentimes also connected with a *"breaking" of a symmetry*, which is another very fundamental concept in physics.

In the first part of this lecture, we will focus on generic aspects of phase transitions. We will learn, how to identify *universal aspects*, for instance, in *critical exponents* of *power laws* for various experimental observables close to a phase transition. Methods and models to describe *critical phenomena* at phase transitions, like Ginzburg-Landau theory, the concept of *scaling,* and *renormalization group* ideas will be introduced. In the send part of the lecture, we will look in more detail at some of the phase transitions being of particular relevance in modern condensed matter theory, like *superconductivity and superfluidity*.

Prerequisites: Bachelor courses Quantum mechanics & Thermodynamics/statistics

Lecture: Monday 11 – 13, N24/251 and Tuesday 15-16, O27/122

Seminar: Tuesday 16-18, O27/122, *Course will start on Monday, October 12*



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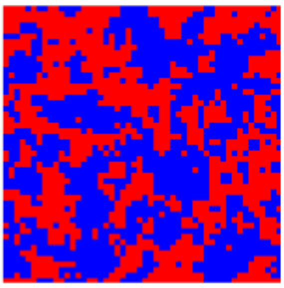

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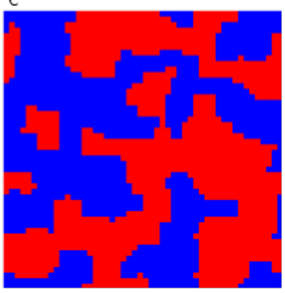

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