Introduction to Complex Systems Summer 2019

Phase Transition — 21.03, 2019

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1 Overview

In the last lecture we talked about non linear dynamics.

In this lecture we discussed phase transitions.

2 Some basic facts

Pressure affects transition between phases. Eg. in high altitudes of Tibet, water boils in 80 degrees C. So, because after getting to the boil temperature, whole heat goes into changing state (phase transition), steam never gets to 100 degrees.

3 Gibbs free energy

Schematic plot for Gibbs free energy shows that thermodynamic potential is symmetric, under some circumstances, between liquid and gas. Ie. body can easily turn into one of those states, but it's hard to change it to different one.

At the meeting point in isolated system, body can spontaneously change states.

4 Supercritical fluid and Curie Temperature

Supercritical fluid is what happens when you heat an isolated system of liquid and gas to the point where velocity of particles of water and gas are identical.

Curie Temperature is a point at which body looses its magnetic properties.

5 Continuous vs discontinuous phase transitions

Latent heat - heat needed to sustain process of phase transition

Hysteresis – the dependence of a system not only on its current environment but also on its past environment.

Continuous phase transition - no latent heat, no hysteresis, no phase coexistence.
Discontinuous phase transition - latent heat, hysteresis, phase coexistence.

6 Order parameter

It is a measure of the degree of order in a system. Denoted as ϕ. It can be denoted as average + fluctuations.

$$\phi(r_i) = \phi + \delta\phi(r_i) \tag{1}$$

Correlation function:

$$g(r_i, r_j) = \phi^2 - < \delta\phi(r_i)\delta\phi(r_j) > \tag{2}$$

Correlation length ξ is characteristic length of a correlation region.